DHCD – Division of Building and Fire Regulation
2006 Code Change Cycle

COMPILATION DOCUMENT
(of all code changes received with staff evaluations)

PART IV

Code changes beginning with a "C" are to the Virginia Construction Code; with an "M" are to the Virginia Maintenance Code; with an "F" are to the Virginia Statewide Fire Prevention Code; with an "I" are to the Virginia Industrialized Building Safety Regulations; with an "A" are to the Virginia Amusement Device Regulations, and with a "CS" are to the Virginia Certifications Standards. The order is as follows: C – M – F – I – A – CS.

PART I contains page numbers 1 – 99 and code changes C-103.1 – C-310.6(R408.1)
PART II contains page numbers 100 – 199 and code changes C-310.6(R602.3) – C-408.8
PART III contains page numbers 200 – 303 and code changes C-503 – C-2803.1(M701.1)
PART IV contains page numbers 304 – 408 and code changes C-2804.1(FG310.1) – C-3501.1-c
PART V contains page numbers 409 – 502 and code changes C-3501.1-d – F110.1
PART VI contains page numbers 503 – 606 and code changes F-111.1 – CS-41

VIRGINIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
DIVISION OF BUILDING AND FIRE REGULATION

2006 Code Change Cycle – Code Change Evaluation Form

USBC – Virginia Construction Code
Code Change Nos. C-2804.1(FG310.1), C-2701.1.1(E250.104), C310.6(G2410.1) and C-310.6(E3509.7)

Nature of Changes: (text is on code change form)

To add a requirement that Corrugated Stainless Steel Tubing (CSST) gas piping be bonded to the electrical system near the point of entrance with a No. 6 copper bonding jumper.

Proponent: Cutting Edge Solutions LLC

Staff Comments:

These proposals add identical language in the gas piping and electrical sections of the International Residential Code, the International Fuel Gas Code and the National Electrical Code. The proposals are the result of problems arising in field installations of CSST being affected by indirect lightning strikes resulting in property damage. All CSST manufacturers are now requiring the bonding in their manufacturer's installation instructions. Similar proposals have been submitted to the national codes groups with varying success in changing the national standards.

The proposals were considered by Workgroup 3 and did not achieve a consensus recommendation. Representatives of the electrical industry and inspectors' associations have submitted opposition papers and documentation.

Staff notes that Code Change Nos. C-112.3.1 (deleting manufacturer's installation instructions) and C-2804.1(FG404.8.1) (requiring a dielectric fitting on LP gas piping) are related to these changes.

Codes and Standards Committee Action:

_____ Approve as presented. _____ Disapprove.

_____ Approve as modified (specify):

_____ Carry over to next cycle. _____ Other (specify):

DEPT. OF HOUSING AND COMMUNITY DEVELOPMENT REGULATORY CHANGE FORM

(Use this form to submit changes to building and fire codes)

Address to submit to:	7/27/07	Document No. C-2804.1(FG310.1)
DHCD, the Jackson Center 501 North Second Street Richmond, VA 23219-1321 Tel. No. (804) 371 – 7150 Fax No. (804) 371 – 7092 Email: bhcd@dhcd.state.va.us		Committee Action: _____ BHCD Action: _____

Submitted by: __Robert Torbin_____ Representing: __Cutting Edge Solutions LLC_____

Address: _70 Flanagan Drive Framingham, MA 01701_____ Phone No.: _(508) 877-9239_____

Regulation Title: _Uniform Statewide Building Code_____ Section No(s): _Chapter 28 Mechanical_____

Proposed Change:

Modify Sections 309.1 and 310.1 of the 2003 International Fuel Gas Code as follows:

309.1 Gas piping shall not be used as a grounding conductor or electrode.

310.1 Gas pipe bonding. Each aboveground portion of a gas piping system that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping shall be considered to be bonded when it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance.
CSST gas piping systems shall be bonded to the electrical service grounding electrode system at the point where the gas service enters the building. The bonding jumper shall not be smaller than 6 AWG copper wire.

Supporting Statement:

Gas piping systems installed inside buildings can become energized by nearby lightning strikes. Conventional bonding of CSST gas piping through the equipment grounding conductor (IFGC 310.1 and NEC 250.104(B)) has proven inadequate (in these circumstances) to prevent the potential for arcing between the gas piping and other nearby electrically conductive systems. There are published technical articles that describe the arcing damage inflicted on CSST gas piping caused by indirect lightning strikes. CSST manufacturers have collectively reported damage to several systems caused by improper or inadequate bonding resulting in fire damage or loss of property. Therefore, modifications are proposed to Sections 309 and 310 to require a direct method of bonding for the CSST gas piping to the electrical grounding system to raise the minimum threshold of protection from all threats (including indirect lightning strikes) that are likely to energize the piping. Results from electrical testing of the proposed bonding method have demonstrated an order of magnitude improvement in dissipating the effects of high energy pulses. Current bonding of other gas piping materials through the equipment grounding conductor will continue to be permitted. This exact language has also been submitted to the ANSI Z223.1 National Fuel Gas Code for the 2009 cycle and has been accepted by its Technical Committee for public review and comment. The manufacturers of CSST have already updated their Design and Installation instructions or issued Technical Bulletins to reflect this new requirement.

DEPT. OF HOUSING AND COMMUNITY DEVELOPMENT REGULATORY CHANGE FORM

(Use this form to submit changes to building and fire codes)

Address to submit to: DHCD, the Jackson Center 501 North Second Street Richmond, VA 23219-1321 Tel. No. (804) 371 – 7150 Fax No. (804) 371 – 7092 Email: bhcd@dhcd.state.va.us	7/27/07	Document No. C-270[1.1(E250.104) Committee Action: _____ BHCD Action: _____

Submitted by: __Robert Torbin_____ Representing: __Cutting Edge Solutions LLC_____

Address: _70 Flanagan Drive Framingham, MA 01701_____ Phone No.: _(508) 877-9239_____

Regulation Title: _Uniform Statewide Building Code_____ Section No(s): _Chapter 27 Electrical_____

Proposed Change:

Modify Section 250.104(B) of the 2002 National Electrical Code as follows:

250.104 Bonding of Piping Systems and Exposed Structural Steel.

B) Other Metal Piping. Where installed in or attached to a building or structure, metal piping system(s), including gas piping, that is likely to become energized shall be bonded to the service equipment enclosure, the grounded conductor at the service, the grounding electrode conductor where of sufficient size, or to the one or more grounding electrodes used. The bonding jumper(s) shall be sized in accordance with 250.122, using the rating of the circuit that is likely to energize the piping system(s). The equipment grounding conductor for the circuit that is likely to energize the piping shall be permitted to serve as the bonding means. The points of attachment of the bonding jumper(s) shall be accessible.

Exception: CSST gas piping systems shall be bonded to the electrical service grounding electrode system at the point where the gas service enters the building. The bonding jumper shall not be smaller than 6 AWG copper wire.

Supporting Statement:

Gas piping systems installed inside buildings can (and have) become energized by nearby lightning strikes. Conventional bonding of CSST gas piping through the equipment grounding conductor (IFGC 310.1 and NEC 250.104(B)) has proven inadequate (in these circumstances) to prevent the potential for arcing between the gas piping and other nearby electrically conductive systems. There are published technical articles that describe the arcing damage inflicted on CSST gas piping caused by indirect lightning strikes. CSST manufacturers have collectively reported damage to several systems caused by improper or inadequate bonding resulting in fire damage and loss of property. Therefore, a modification is proposed to IRC Section E3509.7 to require a direct method of bonding for the CSST gas piping to the electrical grounding system to raise the minimum threshold of protection from all threats (including indirect lightning strikes) that are likely to energize the piping. Results from electrical testing of the proposed bonding method have demonstrated an order of magnitude improvement in dissipating the effects of high energy pulses. Current bonding of other gas piping materials through the equipment grounding conductor will continue to be permitted. This exact language has also been submitted to the ANSI Z223.1 National Fuel Gas Code for the 2009 cycle and has been accepted by its Technical Committee for public review and comment. The manufacturers of CSST have already updated their Design and Installation instructions or issued Technical Bulletins to reflect this new requirement.

DEPT. OF HOUSING AND COMMUNITY DEVELOPMENT REGULATORY CHANGE FORM

(Use this form to submit changes to building and fire codes)

Address to submit to: DHCD, the Jackson Center 501 North Second Street Richmond, VA 23219-1321 Tel. No. (804) 371 – 7150 Fax No. (804) 371 – 7092 Email: bhcd@dhcd.state.va.us	7/27/07	Document No. C-310.6(G2410.1) Committee Action: _____ BHCD Action: _____

Submitted by: __Robert Torbin_____ Representing: __Cutting Edge Solutions LLC_____

Address: _70 Flanagan Drive Framingham, MA 01701_____ Phone No.: _(508) 877-9239_____

Regulation Title: _Uniform Statewide Building Code_____ Section No(s): _Chapter 3 (IRC)_____

Proposed Change:

Modify Chapter 24: Sections G2410.1 and G2411.1 of the 2003 International Residential Code as follows:

G2410.1 (309.1) Grounding. Gas piping shall not be used as a grounding conductor or electrode.

G2411.1 (310.1) Gas pipe bonding. Each aboveground portion of a gas piping system that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping shall be considered to be bonded when it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance.
CSST gas piping systems shall be bonded to the electrical service grounding electrode system at the point where the gas service enters the building. The bonding jumper shall not be smaller than 6 AWG copper wire.

Supporting Statement:

Gas piping systems installed inside buildings can (and have) become energized by nearby lightning strikes. Conventional bonding of CSST gas piping through the equipment grounding conductor (IFGC 310.1 and NEC 250.104(B)) has proven inadequate (in these circumstances) to prevent the potential for arcing between the gas piping and other nearby electrically conductive systems. There are published technical articles that describe the arcing damage inflicted on CSST gas piping caused by indirect lightning strikes. CSST manufacturers have collectively reported damage to several systems caused by improper or inadequate bonding resulting in fire damage and loss of property. Therefore, modifications are proposed to IRC Sections G2410.1 and G2411.1 to require a direct method of bonding for the CSST gas piping to the electrical grounding system to raise the minimum threshold of protection from all threats (including indirect lightning strikes) that are likely to energize the piping. Results from electrical testing of the proposed bonding method have demonstrated an order of magnitude improvement in dissipating the effects of high energy pulses. Current bonding of other gas piping materials through the equipment grounding conductor will continue to be permitted. This exact language has also been submitted to the ANSI Z223.1 National Fuel Gas Code for the 2009 cycle and has been accepted by its Technical Committee for public review and comment. The manufacturers of CSST have already updated their Design and Installation instructions or issued Technical Bulletins to reflect this new requirement.

DEPT. OF HOUSING AND COMMUNITY DEVELOPMENT REGULATORY CHANGE FORM

(Use this form to submit changes to building and fire codes)

Address to submit to: DHCD, the Jackson Center 501 North Second Street Richmond, VA 23219-1321 Tel. No. (804) 371 – 7150 Fax No. (804) 371 – 7092 Email: bhcd@dhcd.state.va.us	7/27/07	Document No. C-310.6(E3509.7) Committee Action: _____ BHCD Action: _____

Submitted by: __Robert Torbin_____ Representing: __Cutting Edge Solutions LLC_____

Address: _70 Flanagan Drive Framingham, MA 01701_____ Phone No.: _(508) 877-9239_____

Regulation Title: _Uniform Statewide Building Code_____ Section No(s): _Chapter 3 (IRC)_____

Proposed Change:

Modify Chapter 35: Section E3509.7 of the 2003 International Residential Code as follows:

E3509.7 Bonding other metal piping. Where installed in or attached to a building or structure, metal piping systems, including gas piping, capable of becoming energized shall be bonded to the service equipment enclosure, the grounded conductor at the service, the grounding electrode conductor where of sufficient size, or to the one or more grounding electrodes used. The bonding jumper shall be sized in accordance with Table E3808.12 using the rating of the circuit capable of energizing the piping. The equipment grounding conductor for the circuit that is capable of energizing the piping shall be permitted to serve as the bonding means. The points of attachment of the bonding jumper(s) shall be accessible.

Exception: CSST gas piping systems shall be bonded to the electrical service grounding electrode system at the point where the gas service enters the building. The bonding jumper shall not be smaller than 6 AWG copper wire.

Supporting Statement:

Gas piping systems installed inside buildings can (and have) become energized by nearby lightning strikes. Conventional bonding of CSST gas piping through the equipment grounding conductor (IFGC 310.1 and NEC 250.104(B)) has proven inadequate (in these circumstances) to prevent the potential for arcing between the gas piping and other nearby electrically conductive systems. There are published technical articles that describe the arcing damage inflicted on CSST gas piping caused by indirect lightning strikes. CSST manufacturers have collectively reported damage to several systems caused by improper or inadequate bonding resulting in fire damage and loss of property. Therefore, a modification is proposed to IRC Section E3509.7 to require a direct method of bonding for the CSST gas piping to the electrical grounding system to raise the minimum threshold of protection from all threats (including indirect lightning strikes) that are likely to energize the piping. Results from electrical testing of the proposed bonding method have demonstrated an order of magnitude improvement in dissipating the effects of high energy pulses. Current bonding of other gas piping materials through the equipment grounding conductor will continue to be permitted. This exact language has also been submitted to the ANSI Z223.1 National Fuel Gas Code for the 2009 cycle and has been accepted by its Technical Committee for public review and comment. The manufacturers of CSST have already updated their Design and Installation instructions or issued Technical Bulletins to reflect this new requirement.

Hodge, Vernon

From: Tomberlin, Guy [Guy.Tomberlin@fairfaxcounty.gov]
Sent: Wednesday, June 20, 2007 11:53 AM
To: Hodge, Vernon; Rodgers, Emory
Cc: rev04@co.henrico.va.us; duplerb@chesterfield.gov; rebartell@co.hanover.va.us; Rick Witt (E-mail); Roger Robertson (E-mail); Wayne Lilly; ger02@co.henrico.va.us; Fortney, Dean; Stillman, Jon K; Lynch, Paul M.; Bob Allen (E-mail); Bob Torbin
Subject: FW: Your question on Grounding and Bonding of Gas Piping
Attachments: Grounding and Bonding Statement.doc

FYI - My question to them was does the installation of a #6 bonding conductor attached to a gas piping system create any code violations of the NEC and the attached is their response. The response appears to support the position that the installation of a #6 bonding conductor on a gas pipe system creates no code violations. Note that the response never indicates there is a problem with any bonding arrangement. It also indicates that underground piping to a pool heater that is bonded is not being used as an electrode. The fact that it is underground and also bonded to the service is "incidental". Again, the main clarification of this response letter is in NFPA's opinion: NO code violations are noted.
Emory please log this supporting information with the USBC proposal submitted by Robert Torbin on the subject of bonding CSST.
If any comments are submitted in opposition to Mr. Torbins proposal can you please forward me the code section violations that may be referred too (if any are produced) so I can send them back to NFPA for further evaluation. They seem to be extremely busy and I want to make sure the BHCD gets the information directly, and in a timely fashion, from NFPA in the same order as the attached letter. Thanks,
Guy Tomberlin, CBO
Land Development Services (LDS)
12055 Government Center Parkway, Suite 630
Fairfax, Virginia 22035-5504
Desk: 703-324-1611
Fax: 703-324-1846

From: Lemoff, Ted [mailto:tlemoff@nfpa.org]
Sent: Wednesday, June 20, 2007 10:18 AM
To: Tomberlin, Guy
Cc: Henderson, Carol; PCABOT@AGA.org; Windell Peters; Buss, Bill
Subject: Your question on Grounding and Bonding of Gas Piping

Dear Mr. Tomberlin,

This is in response to your question on bonding of CSST. Please see the attached statement, which was developed in conjunction with the NFPA Electrical Department. I believe this covers the issues you raise in you questions.

I apologize for the delay in this response, due to backlog of correspondence, coordination between departments, and the NFPA Annual Conference earlier this month.

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Please feel free to contact me if you have any additional questions.

Theodore C. Lemoff, PE
Principal Gases Engineer
NFPA
☎ 617 984-7434
617 984-7110
tlemoff@nfpa.org

National Fire Protection Association

1 Batterymarch Park, Quincy, MA 02169-7471
Phone: 617-770-3000 • Fax: 617-770-0700 • www.nfpa.org

Bonding and Grounding of Gas Piping Systems

NFPA 70, National Electrical Code® and NFPA 54, National Fuel Gas Code technical staff have received several requests for interpretation regarding the bonding of premises gas piping systems. The following information provides clarification for many of the issues that have been raised by these inquiries.

NEC Section 250.104 contains requirements for bonding of water piping systems and other metal piping. Metal gas piping systems installed in or attached to a building or structure are required to be bonded in accordance with 250.104(B).

The main issues are bonding to gas piping within a premises and the use of gas piping as a grounding electrode. A grounding electrode system complying with Part III of Article 250 must be provided. Section 250.52(B) prohibits gas piping from being used as a grounding electrode.

Bonding of gas piping to the service is intended to minimize an electric shock hazard for interior piping. As a practical matter, gas utilities use cathodic protection for their underground metal piping to minimize corrosion. For this reason, gas utilities install a dielectric fitting to isolate the gas utility's piping from the supplied customer's piping. Without this isolation, the cathodic protection system would not work because the premises gas piping is bonded to a grounded electrical service.

Bonding to the interior metal piping is required if the piping is likely to become energized. This requirement applies even if the gas piping on the customer premises is run underground to a second building or to an outdoor appliance such as a pool heater. This gas piping is not being relied on as a grounding electrode. The fact that it runs partially underground to some other location is incidental.

Hodge, Vernon

From:	Tomberlin, Guy [Guy.Tomberlin@fairfaxcounty.gov]
Sent:	Thursday, August 09, 2007 3:49 PM
To:	Bhcd
Cc:	Rodgers, Emory; Hodge, Vernon; ger02@co.henrico.va.us; Grace, Richard; guytomberlin@msn.com; btorbin
Subject:	CSST supporting doc and one proposal
Attachments:	NFPA Interpretation.pdf; AGA Comments - Isolation.pdf; Federal Regulations - Isolation.pdf; NAHB Comments.pdf; NEC Handbook.PDF; Code Change LP Isolation.doc

Here are the supporting files I have for Bob Torbin's bonding CSST proposals. All I have left is to send our written testimony. I will get it to you either tonight or late tomorrow evening (before midnight..deadline?).

Thank you,
Guy Tomberlin, CBO
Land Development Services (LDS)
12055 Government Center Parkway, Suite 630
Fairfax, Virginia 22035-5504
Desk: 703-324-1611
Fax: 703-324-1846

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Request for NFPA Interpretation

"Please provide an NFPA interpretation of Sections 250.104 (B) and 250.52 (B) of the 2005 edition of the NEC, NFPA 70. Is a metallic gas piping system that is bonded in accordance with section 250.104(B) considered to be a grounding electrode and therefore in violation of section 250.52(B) or any other NEC sections?

For example, in a residential application, a metallic gas piping system enters the structure and the installer elects to install a clamp on the gas service pipe and run a #6 copper bonding jumper conductor to the electrical service equipment. The gas piping system may or may not have underground/under slab branches serving appliances such as an island cook top or an outside pool heater. I maintain that bonding the gas piping in this manner does not make any underground gas piping become a grounding electrode, despite the fact that the piping is electrically bonded to the grounding electrodes on the premises."

Response to Request NFPA Policy

National Fire Protection Association
1 Batterymarch Park, Quincy, MA 02169-7471
Phone: 617-770-3000 • Fax: 617-770-0700 • www.nfpa.org

Bonding and Grounding of Gas Piping Systems

NFPA 70, National Electrical Code® and NFPA 54, National Fuel Gas Code technical staff have received several requests for interpretation regarding the bonding of premises gas piping systems. The following information provides clarification for many of the issues that have been raised by these inquiries.

NEC Section 250.104 contains requirements for bonding of water piping systems and other metal piping. Metal gas piping systems installed in or attached to a building or structure are required to be bonded in accordance with 250.104(B).

The main issues are bonding to gas piping within a premises and the use of gas piping as a grounding electrode. A grounding electrode system complying with Part III of Article 250 must be provided. Section 250.52(B) prohibits gas piping from being used as a grounding electrode.

Bonding of gas piping to the service is intended to minimize an electric shock hazard for interior piping. As a practical matter, gas utilities use cathodic protection for their underground metal piping to minimize corrosion. For this reason, gas utilities install a dielectric fitting to isolate the gas utility's piping from the supplied customer's piping. Without this isolation, the cathodic protection system would not work because the premises gas piping is bonded to a grounded electrical service.

Bonding to the interior metal piping is required if the piping is likely to become energized. This requirement applies even if the gas piping on the customer premises is run underground to a second building or to an outdoor appliance such as a pool heater. This gas piping is not being relied on as a grounding electrode. The fact that it runs partially underground to some other location is incidental.

June. 2007

AGA Electrical Isolation Comments

Tomberlin, Guy

From: Tomberlin, Guy
Sent: Wednesday, June 13, 2007 1:34 PM
To: 'Wayne Lilly'
Subject: FW: electrical isolation
Attachments: 2003 Guide - Electrical Isolation.pdf

FYI

Guy Tomberlin, CBO
Land Development Services (LDS)
12055 Government Center Parkway, Suite 630
Fairfax, Virginia 22035-5504
Desk: 703-324-1611
Fax: 703-324-1846

From: Cabot, Paul [mailto:PCabot@aga.org]
Sent: Friday, May 04, 2007 10:01 AM
To: Tomberlin, Guy
Subject: RE: electrical isolation

Guy,
Sorry for the delay in getting back to you. Been out of the office and just catching up before another trip.

I have attached the federal regulations regarding electrical isolation of a gas utility's underground system. Also included in the attachment is the guidance describing how utilities may accomplish the electrical isolation. The guidance is published in ANSI GPTC Z380.1 Guide for Gas Transmission and Distribution Piping Systems. Please refer to DOT Regulation 192.467 (b).

The DOT regulations are "performance based" and do not specify the exact type of isolating method. The guidance provides the options that utilities may consider in meeting the intent of the regulations. Therefore, various isolation methods and devices may be used by a utility depending upon the particular service installation.

I hope this helps
Paul

From: Tomberlin, Guy [mailto:Guy.Tomberlin@fairfaxcounty.gov]
Sent: Thursday, May 03, 2007 8:16 AM
To: Cabot, Paul
Subject: FW: electrical isolation

Paul just checking to see if you received my question below? The electrical community is considering proposing an additional requirement of isolation in all cases (I will forward you their most recent comments). I wanted to try and "slow down that bus" and at least not require it for publicly provided utilities. I plan to use your response, because I already know the answer, as justification when I approach them. This whole bonding issue has become quite contentious with some folks!
Thanks,

Guy Tomberlin, CBO
Land Development Services (LDS)
12055 Government Center Parkway, Suite 630
Fairfax, Virginia 22035-5504
Desk: 703-324-1611
Fax: 703-324-1846

From: Tomberlin, Guy
Sent: Friday, April 27, 2007 12:56 PM
To: 'Cabot, Paul'
Cc: 'Ranfone, Jim'
Subject: electrical isolation

Paul,

Does the service riser DOT shutoff valve assembly that all utilities use before the meter/regulator also incorporate a dielectric union that electrical isolates the under ground piping from the house piping? Typically the lockable valve and the union are in a single body. The focus of my question is the electrical isolation issue.

Guy Tomberlin, CBO
Land Development Services (LDS)
12055 Government Center Parkway, Suite 630
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Federal regulation - Electrical Isolation

§192.467

External corrosion control: Electrical isolation.

[Effective Date: 9-5-78]

(a) Each buried or submerged pipeline must be electrically isolated from other underground metallic structures, unless the pipeline and the other structures are electrically interconnected and cathodically protected as a single unit.

(b) One or more insulating devices must be installed where electrical isolation of a portion of a pipeline is necessary to facilitate the application of corrosion control.

(c) Except for unprotected copper inserted in ferrous pipe, each pipeline must be electrically isolated from metallic casings that are a part of the underground system. However, if isolation is not achieved because it is impractical, other measures must be taken to minimize corrosion of the pipeline inside the casing.

(d) Inspection and electrical tests must be made to assure that electrical isolation is adequate.

(e) An insulating device may not be installed in an area where a combustible atmosphere is anticipated unless precautions are taken to prevent arcing.

(f) Where a pipeline is located in close proximity to electrical transmission tower footings, ground cables or counterpoise, or in other areas where fault currents or unusual risk of lightning may be anticipated, it must be provided with protection against damage due to fault currents or lightning, and protective measures must also be taken at insulating devices.

[Issued by Amdt. 192-4, 36 FR 12297, June 30, 1971; Amdt. 192-33, 43 FR 39389, Sept. 5, 1978]

GUIDE MATERIAL

1 ELECTRICAL ISOLATION (§§192.467(a), (b), and (c))

1.1 Insulating devices. (§§192.467(a) and (b))

Insulating devices may consist of insulating flange assemblies (see guide material under §192.147), unions or couplings, or fabricated insulating joints. These devices should be properly rated for temperature, pressure, and dielectric strength. Typical locations where electrical insulating devices should be considered include the following.

(a) At supporting pipe stanchions, bridge structures, tunnel enclosures, piling, and reinforced concrete foundations where electrical contact would preclude effective cathodic protection. It may be necessary to electrically isolate the piping from such a structure, or the piping and structure from adjacent underground piping.

(b) At metallic curb boxes and valve enclosures. These should be designed, fabricated and installed in such a manner that electrical isolation from the piping system will be maintained.

(c) Where a pipe enters a building through a metallic wall sleeve and where it is intended to maintain electrical isolation between the sleeve and the pipe. To accomplish this, insulating spacers should be used.

(d) At river weights, pipeline anchors, and metallic reinforcement in weight coatings. These should be electrically isolated from the carrier pipe and installed so that coating damage will not occur.

(e) Points at which facilities change ownership, such as meter stations and well heads.

(f) Connections to main line piping systems such as gathering or distribution system laterals.

(g) Inlet and outlet piping of inline measuring or pressure regulating stations or both.

(h) Compressor or pumping stations, either in the suction and discharge piping or in the main line immediately upstream and downstream of the station.

(i) In stray current areas.

(j) At the termination of service line connections and entrance piping to prevent electrical continuity with other metallic systems.

1.2 Casings. (§192.467(c))

(a) New installations.

(1) *Spacers and sealing.* All new construction of cased metallic pipelines should provide for the installation of insulating type casing spacers or other suitable means to prevent physical contact between the carrier pipe and casing. The ends of the casing may be sealed with a non-conductive sealing method to prevent mud, silt, and water from entering the annular space between the casing and the carrier pipe. It may be necessary to fill this annular space with a non-conductive type casing filler to ensure continued isolation in those installations where end seals alone may not be sufficient to resist the entrance of water.

(2) *Joining.* Lengths of casing should be joined by a full weld, or other type of joint that will provide an adequate seal against water entrance. Any holes in the casing should be closed by welding, or otherwise sealed.

(3) *Insertion.* Care should be taken during installation to reduce the possibility of electrical shorts. The carrier pipe should be as straight as practical. The internal diameter of the casing should be adequate to ensure physical clearance from the carrier pipe. The carrier pipe should be carefully inspected and all coating damage repaired. Care should be taken during insertion of the carrier pipe. To prevent damage to the coating and spacer, the casing should be clear of any mud, water, or debris prior to insertion of the carrier pipe. When existing buried pipe is being used as

National Home Builder Comments

Tomberlin, Guy

From: Tomberlin, Guy
Sent: Tuesday, June 19, 2007 9:03 AM
To: 'Wayne Lilly'
Subject: FW: Bonding CSST
Attachments: NFPA_54-2006_CA_ on_CSST_Proposals.pdf

FYI - National Home Builders

Guy Tomberlin, CBO
Land Development Services (LDS)
12055 Government Center Parkway, Suite 630
Fairfax, Virginia 22035-5504
Desk: 703-324-1611
Fax: 703-324-1846

From: Brown, Larry [mailto:lbrown@nahb.com]
Sent: Wednesday, June 13, 2007 2:12 PM
To: Tomberlin, Guy
Subject: RE: Bonding CSST

I sit on both the NFPA/AGA 54 TC and the UPC TC. I also sit on the NEC CMP-2 and have been very involved in this.

The 54 TC decided to only require the bonding is CSST is being used. A copy of the TC Action is attached. The UPC TC will extract the same provisions out of NFPA 54. The NEC will also extract these bonding provisions into the NEC.

From my discussions with NFPA NEC staff, the #6 will handle any current imposed on it during a lighting situation. This would be the same as NEC requirements of only requiring a maximum #6 for a ground rod (2005 NEC Section 250.53(E).

The reason the TC decided to only require this additional bonding for CSST is because that is what is in their instructions. The gas piping of a building is already required to be bonded by 2005 NEC Section 250.104(B). From my recollection as an Electric Inspector, this has been the requirement for well over 20 years.

What was the basis of the manufacturer's new minimum bonding requirements in their instruction? No idea. Have not seen and test data for engineer evaluation. In fact, those who I have spoken to have no idea if this will solve the CSST's problem. All of this came out of a class action suit against the manufacturer's of CSST. Apparently, the manufacturer's went ahead and put this bonding requirement into their instructions. Now one must comply with the instructions.

NAHB's Building Product Issues Committee is keeping tabs on this, and the NAHB Research Center is assembling a data / NEC requirement timeline. One thing is, I do not believe there are any reported deaths or injuries related to this purported problem. At this time NAHB is satisfied the TC's actions pose no problem, and is keeping this on the radar as to any future builder liability.

Let me know if you have any other questions.

Lawrence Brown, CBO
Program Manager, Energy Efficiency
Advocacy Group

National Association of Home Builders (NAHB)
1201 15th Street, NW
Washington, DC 20005
202-266-8565
Fax: 202-266-8369
800-368-5242 x8565
mailto:lbrown@nahb.com

From: Tomberlin, Guy [mailto:Guy.Tomberlin@fairfaxcounty.gov]
Sent: Wednesday, June 13, 2007 1:42 PM
To: Brown, Larry
Subject: Bonding CSST

Larry,

Can you provide me with NAHB's position is on the new #6 conductor bonding requirement for CSST required by manufacturers installation instructions??

Guy Tomberlin, CBO
Land Development Services (LDS)
12055 Government Center Parkway, Suite 630
Fairfax, Virginia 22035-5504
Desk: 703-324-1611
Fax: 703-324-1846

TO: GUY TOMBERLIN

NEC - Handbook

ice equipment enclosure, the grounded conductor at the ice, the grounding electrode conductor where of suffi- t size, or to the one or more grounding electrodes used. bonding jumper(s) shall be sized in accordance with .e 250.66 except as permitted in 250.104(A)(2) and 3).

ding the metal water piping system of a building or :ture is not the same as using the metal water piping :m as a grounding electrode. Bonding to the grounding trode system places the bonded components at the same age level. For example, a current of 2000 amperes across t of 6 AWG copper conductor produces a voltage differ- al of approximately 26 volts. Sections 250.104(A)(1) 250.104(A)(3) require the metal water piping system of ilding or structure to be bonded to the service equipment rounding electrode conductor or, where supplied by a er or branch circuit, to the building or structure discon- ing means or grounding electrode conductor. Informa- concerning bonding provisions for buildings with iple occupancies and isolated metal water piping sys- is contained in the commentary for 250.104(A)(2). In those cases where it cannot be reasonably concluded he hot and cold water pipes are reliably bonded through ıanical connections, an electrical bonding jumper is re- d to ensure that this connection is made. Some judgment be exercised for each installation. The special installa- requirements provided in 250.64(A), 250.64(B), and 64(E) also apply to the water piping bonding jumper.

Buildings of Multiple Occupancy In buildings of mul- occupancy where the metal water piping system(s) led in or attached to a building or structure for the idual occupancies is metallically isolated from all other ıancies by use of nonmetallic water piping, the metal piping system(s) for each occupancy shall be permitted bonded to the equipment grounding terminal of the oard or switchboard enclosure (other than service ment) supplying that occupancy. The bonding jumper e sized in accordance with Table 250.122.

n 250.104(A)(2) recognizes that the increased use of etallic water piping mains can result in the interior piping system of a multiple-occupancy building to lated from ground and from the other occupancies. ore, the water pipe is permitted to be bonded to the oard or switchboard that serves only that particular ıncy. The bonding jumper, in this case, is permitted sized according to Table 250.122, based on the size main overcurrent device supplying the occupancy.

ultiple Buildings or Structures Supplied by a Feed- r Branch Circuit(s) The metal water piping sys- tem(s) installed in or attached to a building or structure shall be bonded to the building or structure disconnecting means enclosure where located at the building or structure, to the equipment grounding conductor run with the supply conduc- tors, or to the one or more grounding electrodes used. The bonding jumper(s) shall be sized in accordance with 250.66, based on the size of the feeder or branch circuit conductors that supply the building. The bonding jumper shall not be required to be larger than the largest ungrounded feeder or branch circuit conductor supplying the building.

(B) Other Metal Piping Where installed in or attached to a building or structure, metal piping system(s), including gas piping, that is likely to become energized shall be bonded to the service equipment enclosure, the grounded conductor at the service, the grounding electrode conductor where of sufficient size, or to the one or more grounding electrodes used. The bonding jumper(s) shall be sized in accordance with 250.122, using the rating of the circuit that is likely to energize the piping system(s). The equipment grounding conductor for the circuit that is likely to energize the piping shall be permitted to serve as the bonding means. The points of attachment of the bonding jumper(s) shall be accessible.

FPN: Bonding all piping and metal air ducts within the premises will provide additional safety.

Unlike the metal piping systems covered in 250.104(A), this requirement applies only to metal piping systems that are likely to become energized. What this means is that where metal piping systems and electrical circuits interface through mechanical and electrical connections within equipment, a failure of electrical insulation can result in the connected piping system(s) becoming energized. Gas appliances are a common example of metal gas piping and electrical circuits being connected to a common piece of equipment, and in this case the 250.104(B) requirements apply. The required bonding of these other piping systems can occur at the same locations specified in 250.104(A), or an additional provision within this paragraph permits the equipment grounding conductor of the circuit that is likely to energize the piping as the means for bonding the piping. Typically, the use of an additional bonding jumper is not necessary to comply with this requirement because the equipment grounding connection to the non–current-carrying metal parts of the appliance also provides a bonding connection to the metal piping attached to the appliance. This is a bonding requirement and the other piping is not being used as an electrode. Therefore, this requirement does not conflict with 250.52(B)(1), which prohibits the use of metal underground gas piping as a grounding electrode for electrical services or other sources of supply.

(C) Structural Metal Exposed structural metal that is interconnected to form a metal building frame and is not

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Exception No. 1: A
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Hodge, Vernon

From: Bob Allen [ballen@powhatanva.gov]
Sent: Monday, August 06, 2007 11:41 AM
To: Hodge, Vernon
Subject: FW: Interp request (Log #26167)MC

See below for interp response.

Bob

Bob Allen
Building Official
County of Powhatan
804.598.5620

From: Revels, Greg [mailto:rev04@co.henrico.va.us]
Sent: Wednesday, July 11, 2007 3:35 PM
To: Bob Allen
Subject: RE: Interp request (Log #26167)MC

Dare I ask .....did you consider the possibility of asking the TRB for an interp??

Gregory H. Revels
Building Official
Phone: 804/501-4374
Fax: 804/501-4984

From: Bob Allen [mailto:ballen@powhatanva.gov]
Sent: Wednesday, June 20, 2007 11:24 AM
To: Revels, Greg; duplerb@chesterfield.gov; rebartell@co.hanover.va.us
Cc: Guy.Tomberlin@co.fairfax.va.us; Richard C. Witt (E-mail); ROBERTSONR@chesterfield.gov
Subject: FW: Interp request (Log #26167)MC

Here's what I got back from NFPA on the gas pipe bonding question. Do you think this would suffice to settle the controversy or will this be seen as "just a staff opinion"?
It seems pretty plain to me but I do know what they say about arguing with an inspector.

Bob

Bob Allen
Building Official
County of Powhatan
804.598.5620

From: Cloutier, Mark [mailto:mcloutier@NFPA.org]
Sent: Wednesday, June 20, 2007 9:18 AM
To: Bob Allen

322

Cc: jcarpenter@iaei.org; teco57@aol.com; Henderson, Carol
Subject: RE: Interp request (Log #26167)MC

Bonding and Grounding of Gas Piping Systems

NFPA 70, National Electrical Code® and NFPA 54, National Fuel Gas Code technical staff have received several requests for interpretation regarding the bonding of premises gas piping systems. The following information provides clarification for many of the issues that have been raised by these inquiries.

NEC Section 250.104 contains requirements for bonding of water piping systems and other metal piping. Metal gas piping systems installed in or attached to a building or structure are required to be bonded in accordance with 250.104(B).

The main issues are bonding to gas piping within a premises and the use of gas piping as a grounding electrode. A grounding electrode system complying with Part III of Article 250 must be provided. Section 250.52(B) prohibits gas piping from being used as a grounding electrode. Bonding of gas piping to the service is intended to minimize an electric shock hazard for interior piping. As a practical matter, gas utilities use cathodic protection for their underground metal piping to minimize corrosion. For this reason, gas utilities install a dielectric fitting to isolate the gas utility's piping from the supplied customer's piping. Without this isolation, the cathodic protection system would not work because the premises gas piping is bonded to a grounded electrical service. .
Bonding to the interior metal piping is required if the piping is likely to become energized. This requirement applies even if the gas piping on the customer premises is run underground to a second building or to an outdoor appliance such as a pool water heater. This gas piping is not being relied on as a grounding electrode. The fact that it runs partially underground to some other location is incidental.

From: Henderson, Carol
Sent: Friday, May 11, 2007 3:07 PM
To: Cloutier, Mark
Subject: FW: Interp request (Log #26167)MC

From: Bob Allen [mailto:ballen@powhatanva.gov]
Posted At: Friday, May 11, 2007 2:17 PM
Posted To: EE Pool
Conversation: Interp request
Subject: Interp request

Request submitted by: J. Robert Allen
Title: Building Official
Jurisdiction: County of Powhatan, Virginia

Mailing Address: Building Inspections Department
3834 Old Buckingham Road, Suite F
Powhatan, VA 23139

NFPA Document: National Electrical Code, NFPA 70, 2005 Edition

Background: A debate is stirring among inspectors and contractors across trades concerning the bonding of gas piping within a building. This has come about primarily as the result the recent publication of revised installation instructions by the manufacturers of corrugated stainless steel tubing (CSST). The revised instructions stipulate that the CSST piping installed within a building shall be bonded in a particular manner. The debate concerns whether the method of bonding specified by the manufacturers creates a violation of the National Electrical Code when the bonded piping is also connected to an underground metal supply line. Neither the NEC nor the CSST manufacturer's instructions stipulate that metallic gas piping which is bonded shall be electrically isolated from underground metallic piping. The contention is made that this condition is analogous to a grounding electrode and therefore creates a violation of Sec. 250.52(B) of the 2005 NEC. The manufacturer's instructions stipulate that a #6 copper bonding jumper be connected to the service equipment enclosure, the grounded conductor at the electrical service, the grounding electrode conductor (where of sufficient size), or to one or more of the grounding electrodes used. Nothing stated in the instructions implies that any part of the gas piping will replace the required grounding electrodes.

One part of the argument focuses on the fact that the manufacturer's instructions specify use of a jumper that may exceed the minimum jumper size determined from Table 250.122. Another item of debate concerns the fact that the manufacturer requires bonding without regard to whether the piping is "likely to become energized", as stated in 250.104(B), however, the code does not appear to prohibit bonding of piping that is unlikely to become energized.

Because this appears to be an interpretive issue, I have framed two questions that I hope address all of these issues.

1. **When metallic piping systems, including gas piping, installed on or within a building or structure are bonded in accordance with 250.104(B), utilizing a bonding jumper sized to meet or exceed the minimum requirements of 250.122, and the building electrical system is provided with electrodes permitted for grounding in accordance with 250.52(A), does a violation of 250.52(B) exist if the bonded piping connects to underground metallic supply piping?**

2. **Is a violation of created when metal piping systems, as described above, are bonded in accordance with 250.104(B) but are unlikely to become energized?**

Bob Allen
Building Official
County of Powhatan
804.598.5620

From: Dupler, Bill [mailto:DuplerB@chesterfield.gov]
Sent: Monday, August 06, 2007 3:54 PM
To: Rodgers, Emory
Subject: Bonding of CSST Fuel Gas piping

I support the code change to bond CSST Fuel Gas Piping.
Attached is the info you requested on our practices here locally. Also attached is the Gastite company's most recent bulletin on this subject and their installation instructions.

<<csst.pdf>> <<DOC000 (5).PDF>> <<DOC (36).PDF>> <<DOC (37).PDF>> You will see that our policy is to require Manufacturers instructions be followed for bonding of CSST. I believe the code as currently written instructs us to do this. I also recall from my training as a residential inspector in Northern Virginia that gas piping was always bonded with a # 6 solid copper conductor to the electrical service and this was the common practice for many years.

Personally I don't see what all the hullabaloo is about.

Bill Dupler
Building Official
Chesterfield County
P.O. Box 40
Chesterfield, VA 23832
Telephone: 804-748-1611 Fax: 804-751-2249
E-mail: duplerb@chesterfield.gov

Chesterfield County, Virginia

Memorandum

DATE: May 16, 2007

TO: Inspection and Plan Review Division Personnel

FROM: William D. Dupler

SUBJECT: Bonding of Gas Piping

Recently a number of issues have come forward regarding this issue. In order to be able to consistently enforce provisions of the code, I am establishing the following criteria for new installations of CSST gas piping in residential construction:

1. All gas piping shall be bonded in accordance with Sec. G 2411.1 of the IRC; this allows use of the equipment grounding conductor in lieu of the more traditionally used solid #6 on steel gas pipe.

2. Any installation in which the contractor chooses to use #6 solid copper to bond gas pipe shall be equally permissible in accordance with Sec. E 3509.7 of the IRC.

3. When a specific bonding method is required by a manufacturer's installation requirements the requirements of Sec. 112.3.1 are not set aside by other sections of the codes. Taken together with other code provisions and the listing requirements the most restrictive provision (in this case of the largest size bonding conductor) is required.

Attachments
A. Ross Memo
Mfg. Installation Instructions

Titeflex Corporation
603 Hendee Street
P.O. Box 90054
Springfield, MA 01139-0054
Telephone 413-739-5631
Facsimile 413-739-7325
www.gastite.com

From: Titeflex Corporation
Manufacturer of Gastite® Flexible Gas Piping

Date: July 19, 2007

19/4435 **********AUTO**MIXED AADC 060
William Dupler
County of Chesterfield
PO Box 40
Chesterfield VA 23832-0040

Re: Gastite Technical Bulletin TB2007-01, 01-26-07
Electrical Bonding of Gastite Corrugated Stainless Steel Tubing (CSST)

Titeflex (Gastite) has been working with many organizations within the model code, natural/LP gas, construction, and regulatory communities to resolve installation issues affecting the electrical bonding of CSST systems. As a result, Gastite has incorporated the technical concerns and the code requirements involved with the bonding of CSST to the electrical grounding system into its Technical Bulletin. The updated bulletin describes the direct-bonding requirement for our piping system and we are asking for your support in adopting it. Our direct-bonding requirement is intended to provide a higher level of consumer protection against events that could energize any of the metallic pathways to ground installed within the home, including the CSST gas piping system.

Gastite's updated direct-bonding requirements will improve the level of consumer safety, are cost effective and are simple to understand and install. This simplified direct-bonding approach requires the following three steps:

- All CSST systems must be bonded directly to one of the grounding electrodes or to the grounding electrode conductor.
- The bonding shall require the use of a No. 6 AWG copper wire for all residential installations. Commercial applications should be handled as an engineered approach.
- The point of attachment shall be a CSST fitting or steel pipe component of the system and not directly to the CSST itself.

The attached Technical Bulletin provides the detailed requirements for bonding Gastite CSST systems. Most states and municipalities already require or allow this bonding methodology. Minnesota is the most recent state to require this practice, adopting the attached direct bonding requirement in January 2007. We are currently in discussions with state and national code organizations and believe that all residential fuel gas systems will be bonded in this manner in the future.

Gastite has already initiated a program to convey this requirement across North America, and will continue to provide technical support, training for inspectors and installers, and educational materials to appropriate organizations. We are leading a national effort to update all of the pertinent model codes within the shortest time frame consistent with the code change cycles.

Gastite will provide assistance to each and every state and/or jurisdiction that wishes to adopt either a statewide amendment or local code change. For further information or training assistance on direct bonding of CSST systems please contact Gastite Engineering (800) 662-0208 or e-mail gastite@titeflex.com.

Titeflex Corporation
603 Hendee Street
Springfield, MA 01139
Tel. 800-662-0208
Fax. 413-739-7325
www.gastite.com
gastite@titeflex.com

Technical Bulletin #TB2007-01 01-26-07

Electrical Bonding of Gastite® CSST

January 26, 2007

This Technical Bulletin provides requirements for the direct bonding of Gastite® CSST. These requirements supersede any prior documents and are mandatory manufacturer's instructions until such time as requirements are adopted by the appropriate national/state model codes and direct bonding installation instructions are specified therein. This document replaces Technical Bulletin TB2006-04 and Section 4.10 Electrical Bonding/Grounding of the November 2006 Gastite Design & Installation Guide. This Technical Bulletin is effective for all Gastite® CSST installed from this date forward.

Direct bonding of Gastite® CSST is required for all gas-piping systems incorporating Gastite® CSST whether or not the connected gas equipment is electrically powered. This requirement is provided as part of the manufacturer's instruction for single-family and multi-family buildings. Bonding for commercial applications should be designed by engineers knowledgeable in electrical system design and the local electrical code.

Gastite® CSST installed inside or attached to a building or structure shall be electrically continuous and direct bonded to an effective ground-fault current path. The gas piping system shall be considered to be direct bonded when installed in accordance with the following:

The piping is permanently and directly connected to the electrical service equipment enclosure, the grounded conductor at the electrical service, the grounding electrode conductor (where of sufficient size) or to one or more of the grounding electrodes used. A single bond shall be made at or near the service entrance of the structure or the gas meter of each individual housing unit within a multi-family structure. The bonding conductor shall be 6 AWG copper wire. Bonding jumpers shall be attached in an approved manner in accordance with NEC-2005 Article 250.70 and the point of attachment for the bonding jumper shall be accessible. Bonding/grounding clamps listed to UL 467 comply with this requirement. This bond is in addition to any other bonding requirements as specified by local codes.

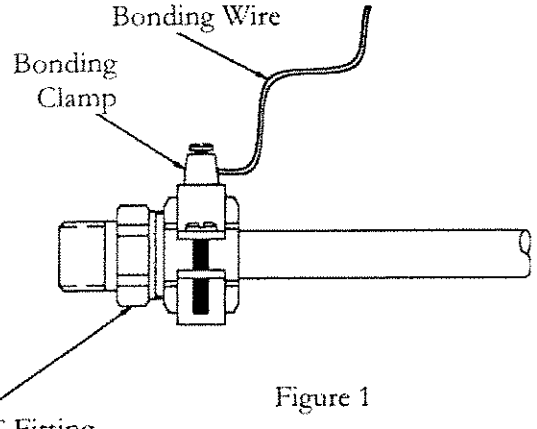

Figure 1

For attachment to the CSST gas piping system, a single bonding clamp must be attached to either a Gastite® brass fitting, a steel manifold or to any rigid pipe component. The corrugated stainless steel tubing portion of the gas piping system shall not be used as the point of attachment of the bonding conductor at any location along its length under any circumstances. See Figures 1, 2 and 3.

Proper bonding and grounding may reduce the risk of damage and fire from a lightning strike. Lightning is a highly destructive force. Even a nearby lightning strike that does not strike a structure directly can cause systems in the structure to become energized. If the systems are not properly bonded, the differences in potential between the systems may cause the charge to arc to another system. Arcing can cause damage to CSST. Bonding and grounding as set forth above should reduce the risk of arcing and related damage.

Depending upon conditions specific to the location of the structure in which the Gastite system is being installed, including but not limited to whether the area is prone to lightning, the owner of the structure should consider whether a lightning protection system is necessary or appropriate. Lightning protection systems are beyond the scope of this manual, but are covered by NFPA 780, the Standard for the Installation of Lightning Protection Systems, and other standards.

Titeflex Corporation
603 Hendee Street
Springfield, MA 01139
Tel. 800-662-0208
Fax. 413-739-7325
www.gastite.com
gastite@titeflex.com

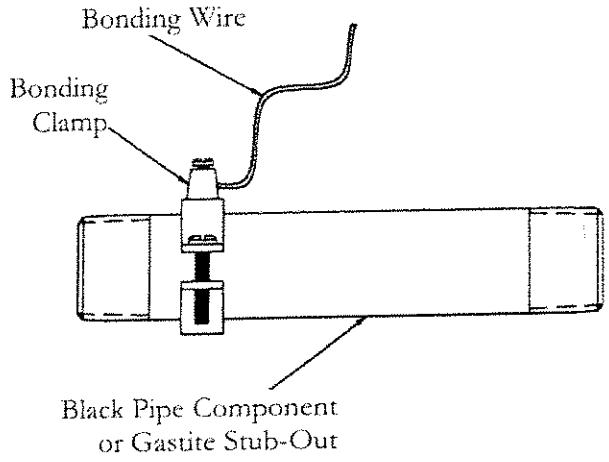

Figure 2

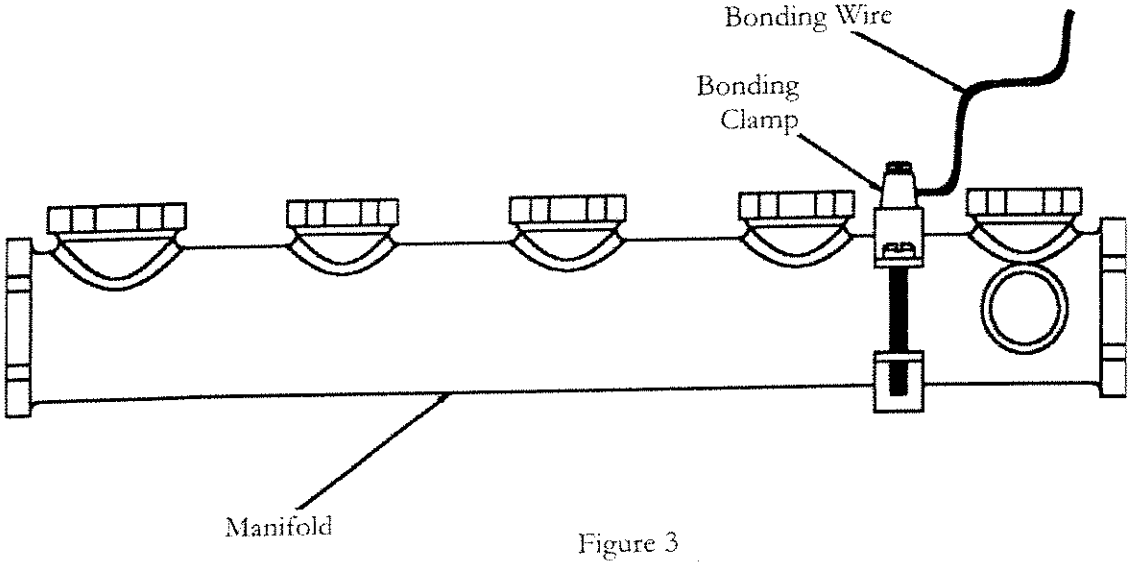

Figure 3

Hodge, Vernon

From: Rodgers, Emory
Sent: Tuesday, April 24, 2007 4:50 PM
To: Guy Tomberlin; Hodge, Vernon
Subject: FW: CAST pipe

Guess my vision for a resolution went out the window. At least the issue is properly framed.

From: Humphrey, David [mailto:hum@co.henrico.va.us]
Sent: Tuesday, April 24, 2007 4:14 PM
To: Rodgers, Emory
Subject: RE: CAST pipe

Good Afternoon Mr. Rodgers,

The issue can be resolved by requiring isolation from earth via nonconductive dielectric fittings or plastic type gas pipe to the building. Then it becomes an enforcement issue. This issue is occurring nationally. New Jersey says the pipe is bonded effectively as per nfpa 54 when nfpa 70 section 250.104(B) is followed. My assessment is that creating a functional electrode out of the gas pipe , if the pipe is in contact with earth, is not a greater requirement than the existing nec language, it is in fact an undesirable outcome. We must then use the NEC not the manufacturers recommendations, as the NEC method of bonding these gas pipes if earth contact is the case produces the most favorable overall result. The manufacturer should choose a means to make the product acceptable in a way that does not have a deleterious effect on the other portions of the gas piping system.

If I may be of assistance please do not hesitate to call.

David G. Humphrey

-----Original Message-----
From: Rodgers, Emory [mailto:Emory.Rodgers@dhcd.virginia.gov]
Sent: Tuesday, April 24, 2007 2:47 PM
To: Humphrey, David
Cc: Hodge, Vernon; Guy Tomberlin
Subject: RE: CAST pipe

All this issue is on our agenda as Work Group 3 and was one of the last issue surfacing based on ICC code changes and recent industry advisory releases. If I understand, and that maybe doubtful, we cannot have the past, current or new USBC be unclear nor allow for IFGC and NEC to be non-uniform on this issue. What do we do now and what has been the problems following either path of discussion herein? We do want our mech/plumbing/eletctrial/combinations inspectors on the same page and not have conflicts with trade contractors. I see from the emails the issues to fairly clear and laid out so at ICC/NEC and here I see a solution.

From: Humphrey, David [mailto:hum@co.henrico.va.us]
Sent: Tuesday, April 24, 2007 12:07 PM
To: Rodgers, Emory
Subject: RE: CAST pipe

-----Original Message-----
From: Humphrey, David
Sent: Tuesday, April 24, 2007 8:48 AM
To: 'Tomberlin, Guy'

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Cc: 'waynel@ci.harrisonburg.va.us'; 'radkins@pwcgov.org'; Gerber, Charles; 'stanleyje@chesterfield.gov'; 'John.Catlett@alexandriava.gov'; 'emoryrodgers@dhcd.virginia.gov'; 'Bormans@co.chesterfield.va.us'
Subject: RE: CAST pipe

Good Morning Guy,

Evidently my explanation of the functioning of the electrode system vs system bonding was not clear. Again the sizing of the bonding jumper to the gas pipe that is required is based on the size of the equipment grounding conductor of the circuit that may energize the system. Using the larger conductor may certainly create a lower impedance path than that of the established electrode system(ground rods). (The gas pipe does not become part of the electrode system when bonded as per 250.104.)
I also have talked with Mr. Phil Simmons one of the foremost experts on grounding world wide and he understands the concern about using the gas piping this way when there is no electrical isolation from the system to earth.

Incidentally 250-80(B) of the 1978 NEC requires the sizing to be based on the equipment grounding conductor of the circuit likely to energize the piping and permits the equipment grounding to be used for this function and has remained in place since. Prior to 78 it was by inference referencing 250.95. (Hardly a recent change.)

The method that is under discussion is different than the code prescribes (hence the perceived need for a code change) and any unintended consequences of this difference should be fully explored as to the effect of this change on other building systems and components.

I agree that IAEI, VBCOA, VPMIA and the members associated with these organization should work together. Perhaps discussion on such issues should take place prior to code change submissions when the other groups are greatly effected. Talking before, rather than demanding support afterwards is generally a better way.

I would look forward to working on this issue with you in future.

David G. Humphrey
Electrical Engineer
County of Henrico VA.

-----Original Message-----
From: Tomberlin, Guy [mailto:Guy.Tomberlin@fairfaxcounty.gov]
Sent: Tuesday, April 24, 2007 7:25 AM
To: Humphrey, David
Cc: Subject: RE: CAST pipe

Dave, NEC section 250.104(B) says to bond gas piping to the electrical service, therefore, like it or not, you have made the underground gas piping intimately part of the grounding electrode system. This does NOT violate 250.52(B) which simply says that gas piping is not to be used or considered as a grounding electrode. (e.g. gas piping is not a choice when you are picking your grounding electrodes.) If one takes 250.52(B) too literally, it would prevent you from slapping a bonding jumper and clamp on the gas piping as section 250.104 mandates that you do!! These two NEC sections are not mutually exclusive, instead they stand alone.
This practice has been going on for decades and only recently did the NEC

change to allow the appliance branch circuit grounding conductor to serve as the bonding means. Throughout the USA, bonding the gas pipe to the service with a # 6 conductor has been the normal practice for steel, copper and now, CSST systems.

Frankly I am disappointed, I thought this was going to be an issue where the VA code enforcement organizations along with industry could come together and develop a position to increase public safety for the citizens of VA. Your comments below "I disagree with the assertion by Guy that we are not creating a hazard. I intend to recommend that IAEI oppose VPMIA's electrical code change proposal." insinuates this is a plumbing vs. electrical issue. You apparently did not read the attached proposal which has already been submitted to the USBC. It was submitted by Robert Torbin representing Cutting Edge Solutions to the International Fuel gas Code, not by me or VPMIA and not to the NEC. Mr. Torbin is a well respected PHD who has been instrumental in the development and implementation of CSST, he is not a plumber nor a member of VPMIA. CSST is a huge industry not that much different than the wire manufacturing industry that you maybe more familiar with. By comparison I wonder if when AC cable was first introduced, was there this level of controversy if the leader line wrapped around the jacket was really a ground or not? I simply saw this as an opportunity for VPMIA to partner with industry on an issue that has already been nationally incorporated. This is current code! Manufacturer's requirements are supposed to be enforced according to the USBC. In addition this code change already passed the first half of the NFPA 54 (ANSI Z 223) National Fuel Gas code change process, so it will automatically be introduced into the 2009 International Fuel Gas Code. VPMIA has a code committee where we discuss these type issues and we voted unanimously to submit this is in our name mainly as a good faith attempt to work and partner with industry. I am requesting you forward all of these correspondence to the IAEI code committee to do the same. So far I have only heard your opinion of which I respectfully disagree with. Gas pipe bonding is currently required. This was not a VA issue, it is a national issue. Only now based on you comments that it is a "hazard" has it become an issue at all. According to your assertions we are faced with a bigger issue than the technical issue itself, a contradiction within the trades on application of the codes. Fortunately or unfortunately (however you choose to view it) in the hierarchy of code application the NEC carries no more weight than the IFGC and vice versa. If the plumbing and gas inspectors are going to require CSST gas pipe bonding and electrical inspectors are going to prohibit it, we have a huge problem. This is one great example of why we have organizations and why we need to work together because our customers are the ones who get penalized in this scenario. As code enforcement organizations we must be the ones who determine what is correct here or at least try to help not hinder. If the plumbing and mechanical folks stand on one side of this issue and the electrical folks stand on the other side at the USBC hearings then it will be left up to the Board for Housing and Community Development to decide the outcome for us. This is the wrong approach and wrong solution, I believe working together with the proper code enforcement officials from the all the affected trades, utilizing the most

technically astute individuals on the particular subject matter and application of the code should be the ones who get together and "hammer out" (if necessary) the details and develop a uniform position to present to the BHCD, keeping in mind that the U in USBC stands for uniformity.
Your comments of opposition appear to indicate through an in depth level of scrutiny of the NEC's terminology that this application may be construed as not approved (or a contradiction within the NEC itself exist). We experience these type claims quite often at the code hearings, but I may suggest if the answer is that we simply call things something different, not change a thing technically, then maybe it is okay to start with?

I stand ready to work with you and IAEI and would appreciate the opportunity to start this whole thing over again with a fresh approach committed to getting to the right solution through the right process, working together not against one another.

Guy Tomberlin, CBO
Land Development Services (LDS)
12055 Government Center Parkway, Suite 630
Fairfax, Virginia 22035-5504
Desk: 703-324-1611
Fax: 703-324-1846

From: Humphrey, David [mailto:hum@co.henrico.va.us]
Sent: Monday, April 23, 2007 2:34 PM
To: Gerber, Charles
Cc: Tomberlin, Guy
Subject: RE: CAST pipe

-----Original Message-----
From: Humphrey, David
Sent: Monday, April 23, 2007 1:26 PM
To: 'Tomberlin, Guy'
Subject: RE: CAST pipe

Hello Charlie,

I stated that bonding the gas pipe in this manner would cause the gas pipe to function as an electrode. We can call it bonding however that does not change the way the system will function. Guy referenced the "way bonding effectively works". Bonding generally deals with circuit voltages and establishes a path capable of carrying current likely to be imposed. See definition of Bonding as per article 100 2002 NEC.This is the reason that we are "REQUIRED" to size the bonding conductor based upon 250.122 "as per NEC 250.104(B)" for the "Circuit" that may energize the system.

Again we are dealing with circuit voltages and ratings NOT issues of lightning. 250.66 is used to size water pipe bonds which generally requires a much larger bonding conductor as the size is based on the service conductors. Attaching these much larger conductors to gas piping in contact with earth would likely create a lower impedance path than the established electrode system (ground rods) and thus cause the gas pipe to function as an electrode in violation of NEC 250.52(B). (The manufacturer) references problems with lightning which the earthing of buildings and equipment is the function of a grounding electrode.

(The 10' of metal water pipe in contact with earth is the definition of a water pipe electrode.) 250.52(A)(1)

The dielectric fitting may be now required however I do not believe this has always been the case especially with older systems.

I disagree with the assertion by Guy that we are not creating a hazard. I intend to recommend that IAEI oppose VPMIA's electrical code change proposal.

David G. Humphrey

-----Original Message-----
From: Tomberlin, Guy [mailto:Guy.Tomberlin@fairfaxcounty.gov]
Sent: Monday, April 23, 2007 12:11 PM
To: Gerber, Charles
Cc: Humphrey, David; Bob Torbin; waynel@ci.harrisonburg.va.us; Fortney, Dean; Retzlaff, Carole; James Anjam; radkins@pwcgov.org
Subject: RE: CSST pipe

Charlie, first I have a disclaimer, I do not profess to be an electrical guru. The way I understand it, it appears Dave must be looking at this as something other than it is. He makes two points that are correct in nature but not applicable to the installation this proposal attempts to require. He is absolutely correct in that the gas line is prohibited from serving the structure as a grounding electrode. However that is not what is being proposed. All this does is requires the bonding for the interior CSST gas piping system back to the panel. It makes no difference if it has 10' or more underground. Anyway if metallic pipe extends from below ground to interior (or vice versa) it is required to have a dielectric fitting which breaks the conductivity of the system (IFGC Section 404.8) in order to prevent corrosion. Dave is correct again, simply by virtue that the bond in the panel eventually goes back to ground (the building ground), but that's the way bonding effectively works.
This is currently permitted, in fact, required by current code. We are not creating a conflict and more importantly we are not creating a hazard. The piping manufactures are already requiring this not recommending it so in order to comply with code we are supposed to be enforcing it right now (USBC Section 112.3.1).
Not to mention IFGC Section 310.1 requires bonding of interior gas piping systems; it permits it to occur through the equipment grounding conductor.
I say lets move forward with the submission the way the committee voted on. The proposed language is already going to show up in NFPA 54 and then automatically in the 09 IFGC, why not be proactive?
Guy Tomberlin, CBO
Land Development Services (LDS)

12055 Government Center Parkway, Suite 630
Fairfax, Virginia 22035-5504
Desk: 703-324-1611
Fax: 703-324-1846

From: Gerber, Charles [mailto:ger02@co.henrico.va.us]
Sent: Friday, April 20, 2007 8:43 AM
To: Tomberlin, Guy
Subject: RE: CSST pipe

It is my understanding talking to David Humphrey, the gas piping system is required to be bonded to the electrical system, and that is done through the equipment ground. To connect a larger wire, 6 AWG, would create a situation where the gas piping system would become a grounding electrode, IF the system has piping in the ground for at least 10 feet. If this happens, they would create the problem they are trying to fix by causing the gas piping system to act as the grounding electrode in the event of a lightening strike. The only sure way to protect the CSST piping system is to install a stand alone lightening arrestor system on the house.

From: Gerber, Charles [mailto:ger02@co.henrico.va.us]
Sent: Thursday, April 19, 2007 2:42 PM
To: Tomberlin, Guy
Subject: CSST pipe

Houston.....we have a problem.....

We need to put this code change to the VUSBC for CSST pipe on hold. It appears that the person representing Wardflex has been talking to David Humphrey for quite some time and there is an issue with this bonding method creating a dangerous situation. David said that if done the way proposed, it would cause the gas pipe to act as a grounding electrode, which is prohibited by the NEC. He also told me that this change was presented or is on the table for the NFPA code change and would more than likely not pass. I think in view of this new information, it might be wise for VPMIA and VIAEI to collaborate prior to us submitting and/or supporting this change so none of us have 'Egg on Face'!

Your thoughts?

Charlie

Hodge, Vernon

From: Humphrey, David [hum@co.henrico.va.us]
Sent: Wednesday, July 18, 2007 8:33 AM
To: Hodge, Vernon
Subject: RE: CSST Code Change and Related Info
Attachments: CSST Position Paper-2.doc

Good Morning Vernon,

Attached is the position paper from IAEI on CSST lightning protection .

Please include with the change proposal.

Thanks,

David G. Humphrey
Legislative Committee Chairman
Virginia Chapter IAEI

-----Original Message-----
From: Hodge, Vernon [mailto:Vernon.Hodge@dhcd.virginia.gov]
Sent: Monday, June 25, 2007 2:47 PM
To: Humphrey, David
Cc: Rodgers, Emory; Eubank, Paula
Subject: CSST Code Change and Related Info

Dave,

Attached is the code change we received on the CSST issue and the information submitted by Guy Tomberlin.

Vernon Hodge, Technical Services Manager
Technical Assistance Services Office (TASO)
Division of Building and Fire Regulations
Va. Department of Housing and Community Development
Direct Dial: (804) 371-7174
Email: Vernon.Hodge@DHCD.virginia.gov
Blackberry: (804) 382-2973

Virginia Chapter
International Association of Electrical Inspectors

"Let the Code Decide"

June 29, 2007

The addition of lightning protection requirements as detailed in the proposed changes of the VUSBC Chapter 28 is an issue of great concern to this organization and to the electrical community as a whole. The submitter's lack of substantiation supporting the proposed alterations of the 2003 International Fuel Gas Code (IFGC) sections 309.1 & 310.1 for CSST gas piping gives rise to the concern that these changes may not solve the performance problems that this product has encountered and that the proposed remedy may actually exacerbate the problem.

The following items detail some of the major concerns with the proposed changes to VUSBC Chapter 28 via the revision of the 2003 IFGC 309.1 & 310.1.

1) NFPA 70 (The National Electrical Code) does not address remedies for lightning protection. These requirements are contained in NFPA 780. NFPA 780 has not been adopted by the Virginia Uniform Statewide Building Code.

2) The issues of "bonding" referenced by NFPA 70(NEC) is an issue of bonding for personnel protection from system voltages and currents that may be imposed on the piping system. An example may be a small current induced on gas piping due to the connection to an electric motor. The use of the equipment grounding conductor of the circuit likely to energize the piping as described in NEC section 250.104(B) has long since proven adequate for this purpose.

Attempting to use sections of the NEC to endorse the proposed action or the declaration that some proposed actions do not violate the NEC is a specious argument. The attempt to provide a form of lightning protection for this specific product is outside of the scope of the NEC. The proclivity of gas piping to fail as a result of "lightning" is a condition that appears relatively unique to CSST. The proposed additional bonding has not been substantiated to solve or even improve the performance issues associated with this product.

Bonding for lightning protection as detailed in NFPA 780 requires that all of the grounded media in the structure be bonded together to form an equal potential

between these grounded items and thus help prevent flash over between grounded items that otherwise would be of differing electrical potential. The proposal as submitted falls far short of this requirement. This type of flash over has been documented as the cause of damage to CSST installations which is the basis of this issue. Will bonding CSST in the manner suggested in the proposed change lessen or increase the probability of lightning flash-over and subsequent damage to the gas piping by placing the CSST at a lower electrical potential than other grounded media in the building? I contend this is certainly a possibility though we simply do not have adequate substantiation to make a determination at this time.

3) We are not aware of any nationally recognized testing laboratory "UL, ETL, MET etc." report providing any information to support the proposal in question.

4) The rumors that adoption of this proposal by NFPA 70 for the 2008 NEC has occurred or is imminent are false. NEC Code Making Panel 5 has unanimously rejected (15-0) a similar proposal submitted to that technical committee. "See ROC comment 5-132 " The final adoption vote for the 2008 NEC was conducted on June 6, 2007 in Boston, Massachusetts, with the panel action to reject the proposed change going unchallenged. A report from a member of the NEC Technical Correlating Committee (TCC) was presented to the Virginia Chapter IAEI at the June 18, 2007 membership meeting. This report made clear that no action to adopt any language concerning CSST is before the TCC nor is there any suggestion that such an action is being considered.
"Code Making Panel 5 deals with grounding and bonding requirements of the NEC."

5) To date we aware of no Technical Interim Amendment (TIA) having been approved or submitted to NFPA to support this proposed remedy.

The Virginia Uniform Statewide Building Code has served this Commonwealth well in it's role of promoting the uniform application of codes and standards across Virginia. The proposed amendment asks the VUSBC to engage in the development of technical standards. This is a matter we contend is best left to the respective technical committees that have the resources to evaluate the full impact of such proposals.

It is the opinion of the Virginia Chapter International Association of Electrical Inspectors that these issues concerning the effects and remedies of lightning damage to CSST should be addressed by the various national technical committees and nationally recognized testing labs. Until such information is presented, the Virginia Chapter IAEI must vigorously oppose the inclusion of proposed changes to IFGC 309.1 & 310.1 in the VUSBC.

David G. Humphrey

Legislative Committee Chairman
Virginia Chapter
International Association of Electrical Inspectors

Virginia Chapter
International Association of Electrical Inspectors

"Let the Code Decide"

September 6, 2007

Mr. Emory Rodgers
Deputy Director
Division of Building and Fire Regulation
Department of Housing and Community Development
501 N. Second Street
Richmond, Virginia 23239-1321

Dear Mr. Rodgers:

I would like to bring to your attention the written response to the request of Mr. Guy Tomberlin to obtain a formal position from the International Office of the International Association of Electrical Inspectors regarding the proposed mechanical code change to Chapter 28 of the USBC. The response is written by Mr. James W. Carpenter CEO & Executive Director of IAEI. Mr. Carpenter also serves as the Chairman on the National Electrical Code Technical Correlating Committee and is a member of the NFPA Standards Council.

I would especially like to call to your attention the first of three bullet items in the response by Mr. Carpenter which states,

"The "CSST Position Paper" by David Humphrey does accurately support IAEI's position as taken during the code-making process for the 2008 NEC".

I also call to your attention the second bullet item. CSST proponents in Virginia have asserted that the proposal submitted to the NEC and unanimously defeated by Code Making Panel 5 is somehow different than the USBC code change proposal submitted by Mr. Torbin. In this bullet item NEC Correlating Committee Chairman Mr. James Carpenter refers to these two proposals as "*essentially the same proposal*".

I would request that this letter and the attached letter by Mr. James W. Carpenter of the IAEI International Office be forwarded to the Board of Housing for their consideration.

Respectfully,

David G. Humphrey
Legislative Committee Chairman
Virginia Chapter
International Association of Electrical Inspectors

International Association Of Electrical Inspectors

P.O. Box 830848 • Richardson, Texas 75083-0848
972.235.1455 • fax 972.671.7139 • email: jcarpenter@iaei.org • web site www.iaei.org

August 29, 2007

Guy Tomberlin, CBO
Land Development Services (LDS)
12055 Government Center Parkway, Suite 630
Fairfax, Virginia 22035-5504

Dear Mr. Tomberlin:

I have received your request for an official position of the International Association of Electrical Inspectors concerning a proposed change to the Virginia Uniform Building Code.

First, I will inform you that IAEI does not issue Formal Interpretations on the National Electrical Code. Any position or opinion is for information purposes only and is not intended, nor should it be relied upon, to provide professional consulting services. The local authority having jurisdiction has the final authority for interpreting the Code.

However, I can provide you with the following:

- The "CSST Position Paper" by David Humphrey does accurately support IAEI's position as taken during the code-making process for the 2008 NEC.
- It is interesting to note that the proposal to Chapter 28 of the Virginia Mechanical Code is the essentially the same proposal and comment that were rejected by NEC Code Making Panel 5. The 2008 edition of the NEC was released by the NFPA Standards Council with an effective date of August 15, 2007. There were no appeals to the work of CMP-5 related to that Proposal and Comment.
- Bonding of CSST is still required by Section 250.104(B), Other Metal Piping, but the bonding jumper size was not changed to require it to not be smaller than 6 AWG copper wire. The panel statement can be found in the National Electrical Code Committee Report on Proposals, Proposal 5-239 and the National Electrical Code Committee Report on Comments, Comment 5-132.

If IAEI can be of further assistance you may contact me at the following:

James W. Carpenter
CEO/Executive Director
Phone: (972) 235-1455
Email: jcarpenter@iaei.org

Sincerely,

James Carpenter
CEO/Executive Director

Cc: David Clements, International President
David Humphrey, Virginia Chapter

FISHER ELECTRICAL COMPANY, INC.
P. O. Box 535
Chesterfield, Virginia 23832
(804) 748-7542
FAX (804) 777-9583

August 20,2007

Mr. Emory Rodgers
Department of Housing and Community Development
501 North Second Street
Richmond, VA 23219-1321

Re: Proposed changes to IFGC 209.1 & 310.1 in the VUSBC

Dear Mr. Emory;

I am writing to you today as member of the Central Virginia Electrical Contractors Association, and Master Electrician with 25 years of experience.

We are in agreement with our association, the IAEI, and Mr. Cecil Tune, Chief Inspector for Henrico County Building Department, in regard to the proposed changes to the 2003 International Fuel Gas Code sections 309.1 and 310.1 which in turn would require changing the Virginia Uniform Statewide Building Code, Chapter 28 regarding lighting protection for CSST gas pipe. Fisher Electrical Co., Inc. is strongly opposed the said changes.

Respectfully Submitted;

Daniel H. Fisher
President
Jfm/dhf

Avis Electric Company
8434 Meadowbridge Road
Mechanicsville, VA.23116
DCJS #11-3435 FIN #54-1260317
(804) 730-2112 Fax: (804) 730-7064

August 20, 2007

Mr. Emory Rodgers
Department of Housing and Community Development
501 North Second Street
Richmond, VA 23219-1321

Re: Proposed changes to IFGC 309.1 & 310-1 in the VUSBC

Dear Mr. Emory:

I am an electrical contractor in the Richmond area and a member of CVECA. At a recent meeting I was made aware of some proposed changes to the 2003 International Fuel Gas Code (IFGC) sections 309.1 and 310.1 which in return would require, changing the Virginia Uniform State Wide Building Code, Chapter 23 regarding lightning protection for CSST gas pipe. As an Electrical Contractor, I am strongly opposed to these changes.

Sincerely,

Henry E Bajer

Henry E. Bajer
President

Matthews Construction Co., Inc.

Electrical Pole Line Contractor

August 23, 2007

Mr. Emory Rodgers
Department of Housing and Community Development
501 North Second St.
Richmond, VA 23219-1321

Re: Proposed changes to IFGC 309.1 in the VUSBC

Dear Mr. Emory

As a member of the Central Virginia Electrical Contractors' Association, Inc. (CVECA), I am writing to voice my concern concerning the proposed changes to the Virginia Uniform Statewide Code, Chapter 28 regarding lightning protection for CSST gas pipe. I am strongly opposed and support the CVECA in the Associations opposition as well.

Sincerely,

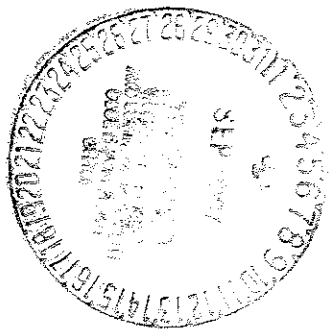
George J. Smith
President/CEO

Joseph S. Smith
Vice President

Matthews Construction Company, INC.

7718 Anoka Road • Richmond, Virginia 23229 • Phone 804.285.7648

BEE & H
ELECTRIC COMPANY
ESTABLISHED 1962



August 30, 2007

DHCD The Jackson Center
501 North Second Street
Richmond, VA 23219-1321

Reference: CSST

To Whom It May Concern:

I' am an Electrical Contractor located in Fairfax, Virginia. I have been in Business for over forty years. We have always complied with the NEC and the Virginia Uniform State Building Code.

We have been notified by the Builder that the Manufacturer of CSST requires us to bond their gas pipe system per the NEC article 250.66 to protect there system from lighting. I could not locate anywhere in the NEC or Statewide Building Code that requires this type of grounding.

I question what is wrong with CSST product and why is the Manufacturer trying to force us to comply with this request without proper testing and reviewed by any nationally recognized testing laboratory. They are trying to put the liability on the Electrical Inspector and the Electrical Contractor.

No changes should be made to there listing until they produce testing results that comply with the NEC and USBC codes.

Thank you,

John C. Belotti
President

2716 DORR AVENUE • FAIRFAX, VIRGINIA 22031 • (703) 560-3278

International Association of Electrical Inspectors

"Eastern Virginia Division, Virginia Chapter, Southern Section"

16 Sunset Road ~ Newport News ~ Virginia ~ 23606-3722

William Beattie, President ~ James Howard, 1st Vice President ~ Jeff White, 2nd Vice President
Herald F. Good, Jr., Secretary/Treasurer

28 August 2007

Mr. Emory Rodgers
Deputy Director
Division of Building and Fire Regulation
Department of Housing and Community Development
501 N Second Street
Richmond, VA 23239-1321

Subject: Position Statement re: CSST Electrical Bonding

Dear Mr. Rodgers:

After careful review of the Virginia Chapter IAEI's position paper dated June 29, 2007 indicating the lack of substantiation for code changes regarding additional electrical bonding for CSST gas piping systems, the following statement is issued with no objections from the Board of Directors of the Eastern Virginia Division International Association of Electrical Inspectors.

"It is the opinion of the Eastern Virginia Division, Virginia Chapter, International Association of Electrical Inspectors that issues concerning the effects and remedies of lightning damage to CSST should be addressed by the various National Technical Committees and Nationally Recognized Testing Laboratories. Until such information is presented and documented, the Eastern Virginia Division, Virginia Chapter, IAEI must oppose the proposed changes to IFGC 309.1 & 310.1 in the VUSBC."

If I can be of further service concerning this matter, please feel free to contact me at your earliest convenience.

In the interest of Electrical Safety and Education, I am...

Respectfully,

Herald F. Good, Jr.
Secretary/Treasurer

ELECTRICOMM inc.
Power • Voice • Data • Video

AUGUST 8 2007

MR EMORY RODGERS
DEPT. OF HOUSING AND COMMUNITY DEVELOPMENT
501 NORTH SECOND STREET
RICHMOND VA 23219-1321

DEAR MR EMORY,

I AM WRITING TODAY WITH REGARDS TO THE PROPOSED CHANGES TO IFGC 309.1 AND 310.1 IN THE VUSBC. AS AN ELECTRICAL CONTRACTOR IN THE STATE FOR THE PAST 30 YEARS AND THE CONTRACTOR OF RECORD FOR THE DEPT OF HOUSING BUILDING, I RESPECTIVELY ASK THAT NO CODE CHANGES BE MADE TO 309.1 & 310.1 UNTIL FURTHER TEST RESULTS ARE IN HAND.

THE GAS PIPE IN QUESTION IS A BRAIDED STAINLESS STEEL HOSE WITH A PLASTIC OUTER JACKET. THE STAINLESS STEEL BRAID IS NOT THE BEST ELECTRICAL CONDUCTOR AND WHEN VOLTAGE IS INTRODUCED ON THE HOSE IT DOES NOT CONDUCT PERFECTLY. THE SIMPLE SOLUTION TO THIS WILL BE TO ADD A COPPER CONDUCTOR AROUND THE BRAID DURING THE MANUFACTURING PROCESS. A SIMILAR CONDUCTOR IS FOUND IN CERTAIN TYPES OF ELECTRICAL "SEAL TITE" FLEXIBLE METALLIC TUBING. SPECIAL ATTENTION MUST ALSO BE PAID TO THE CONNECTION POINTS OF THE SYSTEM FITTINGS.

WE FEEL THAT AN INDEPENDENT TESTING LAB SHOULD STUDY THE CURRENT SITUATION BEFORE ANY CODE CHANGES ARE ENACTED. THANK YOU AND PLEASE FEEL FREE TO CALL WITH ANY COMMENTS OR QUESTIONS. I MAY ALWAYS BE REACHES AT (804) 314-6440.

SINCERELY,

WILLIAM K WELSH
PRESIDENT

C.C. FILE

P.O. Box 1836 • Ashland, Virginia 23005 • Office (804) 752-7574 • Fax (804) 752-3436

Lauterbach Electric Co., Inc.

QUALITY

ELECTRICAL CONTRACTOR

FREE ESTIMATES

4029 MacArthur Avenue • Richmond, Virginia 23227
Phone: 804-553-3900 • FAX 804-553-9939

STATE REG.
No. 17781

August 8, 2007

Mr. Emory Rodgers.
Department of Housing and Community Development
501 North Second St.
Richmond, VA 23219-1321

Re: Proposed changes to IFGC 309.1 & 310.1 in the VUSBC

Dear Mr. Emory:

I have been made aware of some proposed changes to the 2003 International Fuel Gas Code (IFGC) sections 309.1 and 310.1, which in turn would require changing the Virginia Uniform Statewide Building Code, Chapter 28, regarding lightning protection for CSST gas pipe. As a Class A electrical contractor I am vehemently opposed to these changes.

I have read the Virginia Chapter of the International Association of Electrical Inspectors (IAEI) letter, dated June 29, 2007, regarding this issue. I, along with many of my colleagues, fully support the IAEI in their opposition to these changes.

Sincerely,

W. Dwane Chisenhall

W. Dwane Chisenhall
Vice-President
Lauterbach Electric Co., Inc.

ATLEE ELECTRICAL CORPORATION
P.O. BOX 6354
ASHLAND, VIRGINIA 23005
804-537-5149

AUGUST 9, 2007

DEPT. OF HOUSING & COMMUNITY DEVELOPMENT
501 NORTH SECOND STREET
RICHMOND, VA 23219-1321

ATTN: MR. EMORY RODGERS

RE: PROPOSED CHANGES TO IFGC 309.1 AND 310.1 IN THE VUSBC

DEAR MR. RODGERS:

THE DISCUSSION AT OUR LAST MEETING WAS THE PROPOSED CHANGES TO THE IFGC 309.1 AND 310.1 IN THE VUSBC. WE STRONGLY OPPOSE THESE CHANGES. OUR FIRST CONCERN IS SAFETY AND FEEL THESE CHANGES WOULD NOT BE BENEFICIAL TO OUR INDUSTRY.

AS A MEMBER OF THE CENTRAL VIRGINIA ELECTRICAL CONTRACTORS ASSOCIATION (CVECA) FOR THE PAST TWENTY FIVE YEARS, WE HAVE ALWAYS ENJOYED A GOOD, OPEN LINE OF COMMUNICATION WITH THE DIFFERENT LOCALITIES. WE ARE IN FULL SUPPORT OF THE IAEI.

SINCERELY,

KEVIN B. BLUNT
PRESIDENT

KBB/kws

CENTRAL VIRGINIA ELECTRICAL CONTRACTORS' ASSOCIATION, INC.

P.O. Box 27384
Richmond, VA 23261-7384

August 10, 2007

Mr. Emory Rodgers.
Department of Housing and Community Development
501 North Second St.
Richmond, VA 23219-1321

Re: Proposed changes to VUSBC Part 1 Section 112.3.1 and Exception

Dear Mr. Emory:

I am writing you today as the President of the Central Virginia Electrical Contractors' Association, Inc. (CVECA). We are an association of over fifty electrical contractors and electrical distributors active in the industry for well over thirty years. One of the objectives of the CVECA is to promote open communication with local code enforcement authorities. To this end the CVECA meets with the inspectors of the nearby localities to discuss code enforcement and code change issues. At our most recent meeting, the CVECA was made aware of some proposed changes to the Virginia Uniform Statewide Building Code Part I, Section 112.3.1 and exception. The Central Virginia Electrical Contractors Association, Inc. supports these changes as proposed by the Virginia Chapter of the I.A.E.I.

Sincerely,

W. Dwane Chisenhall
President
Central Virginia Electrical Contractors Association, Inc.

B & B ELECTRIC

9982 Lickinghole Road, Ashland, VA 23005

Phone: 804-752-1075 Fax: 804-752-1076

August 14, 2007

Mr. Emory Rodgers
Department of Housing and Community Development
501 North Second Street
Richmond, VA 23219-1321

RE: Proposed changes to IFGC 309.1 & 310.1 in the VUSBC

Dear Mr. Emory,

I am writing you today as Vice President of B & B Electric, member of Central Virginia Electrical Contractors Association (CVECA), Member International Association of Electric Inspectors (IAEI), and member associated General Contractors (AGC).

I would like to express my strong opposition to the proposed changes to IFGC 309.1 & 310.1 in the VUSBC. Please see the enclosed June 29, 2007 letter from the IAEI for an in depth explanation of my (our) position.

Sincerely,

Thomas Blackstone
Vice President
B & B Building Systems, Inc. t/a B & B Electric

Virginia Chapter
International Association of Electrical Inspectors

"Let the Code Decide"

June 29, 2007

The addition of lightning protection requirements as detailed in the proposed changes of the VUSBC Chapter 28 is an issue of great concern to this organization and to the electrical community as a whole. The submitter's lack of substantiation supporting the proposed alterations of the 2003 International Fuel Gas Code (IFGC) sections 309.1 & 310.1 for CSST gas piping gives rise to the concern that these changes may not solve the performance problems that this product has encountered and that the proposed remedy may actually exacerbate the problem.

The following items detail some of the major concerns with the proposed changes to VUSBC Chapter 28 via the revision of the 2003 IFGC 309.1 & 310.1.

1) NFPA 70 (The National Electrical Code) does not address remedies for lightning protection. These requirements are contained in NFPA 780. NFPA 780 has not been adopted by the Virginia Uniform Statewide Building Code.

2) The issues of "bonding" referenced by NFPA 70(NEC) is an issue of bonding for personnel protection from system voltages and currents that may be imposed on the piping system. An example may be a small current induced on gas piping due to the connection to an electric motor. The use of the equipment grounding conductor of the circuit likely to energize the piping as described in NEC section 250.104(B) has long since proven adequate for this purpose.

Attempting to use sections of the NEC to endorse the proposed action or the declaration that some proposed actions do not violate the NEC is a specious argument. The attempt to provide a form of lightning protection for this specific product is outside of the scope of the NEC. The proclivity of gas piping to fail as a result of "lightning" is a condition that appears relatively unique to CSST. The proposed additional bonding has not been substantiated to solve or even improve the performance issues associated with this product.

Bonding for lightning protection as detailed in NFPA 780 requires that all of the grounded media in the structure be bonded together to form an equal potential

between these grounded items and thus help prevent flash over between grounded items that otherwise would be of differing electrical potential. The proposal as submitted falls far short of this requirement. This type of flash over has been documented as the cause of damage to CSST installations which is the basis of this issue. Will bonding CSST in the manner suggested in the proposed change lessen or increase the probability of lightning flash-over and subsequent damage to the gas piping by placing the CSST at a lower electrical potential than other grounded media in the building? I contend this is certainly a possibility though we simply do not have adequate substantiation to make a determination at this time.

3) We are not aware of any nationally recognized testing laboratory "UL, ETL, MET etc." report providing any information to support the proposal in question.

4) The rumors that adoption of this proposal by NFPA 70 for the 2008 NEC has occurred or is imminent are false. NEC Code Making Panel 5 has unanimously rejected (15-0) a similar proposal submitted to that technical committee. "See ROC comment 5-132 " The final adoption vote for the 2008 NEC was conducted on June 6, 2007 in Boston, Massachusetts, with the panel action to reject the proposed change going unchallenged. A report from a member of the NEC Technical Correlating Committee (TCC) was presented to the Virginia Chapter IAEI at the June 18, 2007 membership meeting. This report made clear that no action to adopt any language concerning CSST is before the TCC nor is there any suggestion that such an action is being considered.
"Code Making Panel 5 deals with grounding and bonding requirements of the NEC."

5) To date we aware of no Technical Interim Amendment (TIA) having been approved or submitted to NFPA to support this proposed remedy.

The Virginia Uniform Statewide Building Code has served this Commonwealth well in it's role of promoting the uniform application of codes and standards across Virginia. The proposed amendment asks the VUSBC to engage in the development of technical standards. This is a matter we contend is best left to the respective technical committees that have the resources to evaluate the full impact of such proposals.

It is the opinion of the Virginia Chapter International Association of Electrical Inspectors that these issues concerning the effects and remedies of lightning damage to CSST should be addressed by the various national technical committees and nationally recognized testing labs. Until such information is presented, the Virginia Chapter IAEI must vigorously oppose the inclusion of proposed changes to IFGC 309.1 & 310.1 in the VUSBC.

David G. Humphrey

Legislative Committee Chairman
Virginia Chapter
International Association of Electrical Inspectors

Tolley Electrical Corp.

10981 RICHARDSON ROAD
ASHLAND, VIRGINIA 23005
TELEPHONE (804) 550-2666
FAX (804) 550-2063

August 14, 2007

Department of Housing and Community Development
501 North Second Street
Richmond, VA 23219-1321

Attention: Emory Rodgers

Reference: CSST Gas Piping

Dear Mr. Rodgers,

I have been made aware of a proposed change to the 2003 International Fuel Gas Code, regarding Section 309.1 and 310.1 at the August monthly meeting of the Central VA Electrical Contractors Association. This change would also affect the Virginia Uniform Statewide Building Code - Chapter 28, regarding lightning protection for CSST gas piping.

Tolley Electrical Corporation is opposed to this proposed change. I have been provided with a letter dated June 29, 2007; drafted by the Virginia Chapter of the International Association of Electrical Inspectors (IAEI), stating their position to the proposed change to the 2003 International Fuel Gas Code and the CSST gas pipe issue. Tolley Electrical Corporation supports the IAEI position in opposing the change to the aforementioned code.

Sincerely,

Tolley Electrical Corporation

Russell J. Brooks, III
President

CENTRAL VIRGINIA ELECTRICAL CONTRACTORS' ASSOCIATION, INC.

P.O. Box 27384
Richmond, VA 23261-7384

August 8, 2007

Mr. Emory Rodgers.
Department of Housing and Community Development
501 North Second St.
Richmond, VA 23219-1321

Re: Proposed changes to IFGC 309.1 & 310.1 in the VUSBC

Dear Mr. Emory:

I am writing you today as the President of the Central Virginia Electrical Contractors' Association, Inc. (CVECA). We are an association of over fifty electrical contractors and electrical distributors active in the industry for well over thirty years. One of the objectives of the CVECA is to promote open communication with local code enforcement authorities. To this end the CVECA meets with the inspectors of the nearby localities to discuss code enforcement and code change issues. At our most recent meeting, the CVECA was made aware of some proposed changes to the 2003 International Fuel Gas Code (IFGC) sections 309.1 and 310.1 which in turn would require changing the Virginia Uniform Statewide Building Code, Chapter 28 regarding lightning protection for CSST gas pipe. The Central Virginia Electrical Contractors Association, Inc. is strongly opposed to these changes.

The CVECA was given a letter dated June 29, 2007 written by the Virginia Chapter of the International Association of Electrical Inspectors (IAEI) regarding this CSST gas pipe issue. The Central Virginia Electrical Contractors Association fully supports the IAEI in their opposition to these changes.

Sincerely,

W. Dwane Chisenhall
President
Central Virginia Electrical Contractors Association, Inc.

Hodge, Vernon

From: Humphrey Electric Co., Inc. [humphrey.electric@verizon.net]
Sent: Thursday, August 09, 2007 11:53 AM
To: Hodge, Vernon
Cc: Harold Kelly; David G Humphrey; :PWALSHAK@nvrinc.com
Subject: Harold Kelly Letter.doc

August 9, 2007

Mr. Vernon Hodge
Technical Services Manager
Department of Housing and Community Development
501 North Second Street
Richmond, Virginia 23219

Dear Mr. Hodge:

On behalf of Humphrey Electric Co., Inc., I would like to express our company's strong support of the two policy positions submitted by the International Association of Electrical Inspectors – Virginia Chapter relating to proposed changes to the Virginia Uniform Statewide Building Code.

Specifically, we concur with the IAEI – Virginia Chapter's proposed change to **13 VAC 5-63-120. Section 112.3.1** and fully support the elimination of the current exception which provides that where a code provision is less restrictive than the conditions of the listing of the equipment or appliance, or the manufacturer's installation instructions, the conditions of the listing and the manufacturer's installation instructions shall apply. This is very concerning to us as contractors and Humphrey Electric supports the contention that in those instances wherein a conflict arises between the provisions of the USBC and conditions of the listing of the equipment or appliance, the provisions of the USBC should prevail. This could set up a very difficult situation for contractors and building inspectors. It could also limit competition. For instance, a conduit manufacturer could list in their literature that only a certain manufacturer's fittings, straps, and boxes are to be used with their conduit.

Additionally, Humphrey Electric concurs with the IAEI – Virginia Chapter's opposition to the proposed change to the Virginia Uniform Statewide Building Code Chapter 28 (2003 International Fuel Gas Code Sec. 309.1 and Sec. 310.1). The new manufacturers instructions for CSST specify that an additional bonding connection must be installed between the CSST piping and the grounding electrode system at the point where the gas piping enters a building. A #6 AWG copper wire is to be used to do this. Humphrey Electric is not aware of any ground clamps that are approved for such an installation. Also, according to the National Association of Home Builders Research Center Report #5737-01 080307 section 1.1, "the efficacy of the described bonding practices has not been evaluated". The clear lack of any nationally recognized testing data supporting this proposed modification calls into question both its necessity and efficacy, at this time.

Sincerely,

C. G. Humphrey Jr.
President
Humphrey Electric Co., Inc
(804)794-4877

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VIRGINIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
DIVISION OF BUILDING AND FIRE REGULATION

2006 Code Change Cycle – Code Change Evaluation Form

USBC – Virginia Construction Code
Code Change No. C-2804.1(FG404.8.1)

Nature of Change: (text is on code change form)

To require a dielectric fitting to be installed on liquefied petroleum piping between the tank and the building.

Proponent: Virginia Plumbing and Mechanical Inspectors Association and Virginia Building and Code Officials Association's Plumbing and Mechanical Code Committee

Staff Comments:

This change to the International Fuel Gas Code and the International Residential Code is to assure that underground piping used for LP gas service does not form a grounding electrode system when an oversized bonding jumper from the electrical system is connected to the piping installed inside a building. The proposal is related to Code Change Nos. C-2804.1(FG310.1), C-2701.1.1(E250.104), C310.6(G2410.1) and C-310.6(E3509.7) submitted for the installation of Corrugated Stainless Steel Tubing (CSST).

The proponent has stated that the proposal will be submitted to the International Codes through the national level process. The proposal was not received in time for review by the workgroups used in this code change cycle.

Codes and Standards Committee Action:

_____ Approve as presented. _____ Disapprove.

_____ Approve as modified (specify):

_____ Carry over to next cycle. _____ Other (specify):

VIRGINIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
CODE CHANGE FORM

Address to submit to: DHCD, The Jackson Center 501 North Second Street Richmond, VA 23219-1321 Tel. No. (804) 371 – 7150 Fax No. (804) 371 – 7092 Email: bhcd@dhcd.virginia.gov		Document No. C-2804.1 (FG404.8.1) Committee Action: _____ BHCD Action: _____

Submitted by: Guy Tomberlin Representing: VPMIA/VBCOA Plbg/Mech Code Committee

Address: 12055 Govt. Ctr. Pkwy, Suite 630 Fairfax, VA 22035 Phone No. (703) 324-1611

Regulation Title: USBC 2006 – Fuel Gas Technical Amendments both IFGC and IRC

Section No(s): IFGC Section 408 and IRC Section G 2415.8

Proposed Change:

Add new Section
404.8.1 Isolation. An approved dielectric fitting/connection shall be installed on underground metallic pipe and tubing service lines which extend from LP storage containers. The dielectric fitting/connection shall be installed outside, above ground, after the pipe exits the earth and before it enters the structure.

Supporting Statement:
Electronic isolation is currently required in this location for all federally regulated gas utilities. However LP systems do not typically fall under the guides of federally regulated authority. Now that bonding is clearly required for all CSST systems this will prevent any potential fault back to an outside LP storage tanks.
This proposal will be submitted on the National level.

VIRGINIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
DIVISION OF BUILDING AND FIRE REGULATION

2006 Code Change Cycle – Code Change Evaluation Form

USBC – Virginia Construction Code
Code Change No. C-2804.1(FG503.3.4)

Nature of Change: (text is on code change form)

To require the flow of gas to any cooking appliance to be completely shut off if the damper or power exhaust in the hood or venting system is not operational.

Proponent: Loudoun County

Staff Comments:

The current International Fuel Gas Code (IFGC) requires the gas flow to the main burners to be shut off if the venting system is not operational. The proponent raises concerns about bypass lines installed to keep the pilot lights burning so the burners will not have to be relit manually when the venting system becomes operational. Comments (which are included behind the code change) suggest that the 2006 IFGC language already provides for this. This proposal did not receive consensus support in the workgroup process utilized in this code change cycle.

Codes and Standards Committee Action:

_____ Approve as presented. _____ Disapprove.

_____ Approve as modified (specify):

_____ Carry over to next cycle. _____ Other (specify):

C-2804.1 (FG503.3.4)

Proposed change to the 2003 International Fuel Gas Code (IFGC) Section 503.3.4 Ventilating hoods and exhaust systems

Submitted by;
J.D. Mitchell, Fire Protection Field Supervisor
Loudoun County Department of Building and Development

Proposed change;
Section 503.3.4 of the IFGC needs to be changed to read, " Where **any cooking appliance or cooking equipment, either manually or automatically operated, in addition to any other** automatically operated equipment is vented through a ventilating hood or exhaust system equipped with a damper or power means of exhaust, provisions shall be made to allow the flow of gas to the **appliance or equipment** ~~main burners~~ only when the damper is open to a position to properly vent the equipment and when the power means of exhaust is in operation."

Rational;
Section 503.3.4 of the IFGC deals with when exhaust systems must be in operation. Although not specifically worded as such, this section will pertain to commercial cooking appliances found under kitchen hood exhaust systems. These appliances require the ventilation of grease laden vapors and products of combustion

The current wording of Section 503.3.4 states, "...Where automatically operated equipment is vented through a ventilating hood or exhaust system equipped with a damper or power means of exhaust, provisions shall be made to allow the flow of gas to the main burners only when the damper is open to a position to properly vent the equipment and when the power means of exhaust is in operation."

This Section currently covers "automatic" appliances such as deep fryers, some griddles and ovens, all typically thermostatically controlled appliances. It will not cover ranges, char broilers, some griddles or wok tables, all typically manually controlled. These "manually" controlled appliances still generate grease laden vapors and products of combustion. The proposed change will clarify that all cooking equipment requires ventilation during operation.

Add a new Section to read;
503.3.4.1 Bypass lines and jumpers. Bypass lines and jumpers shall not be installed around any valve or electric solenoid allowing any gas to the appliances or equipment.

Rational;
These bypass lines are being installed on most every kitchen hood system in order to allow gas to keep pilots lit. A kitchen cooking appliance manufacturer was contacted and ask how these bypass lines would affect the operation of their appliance. These lines are not listed, tested nor approved for use with any appliance. Further, use of these lines will void the listing of the appliance. In order to receive a listing from Underwriters Laboratory or Factory Mutual, the appliances are tested with an X size gas line under X

gas pressure. If the appliance calls for a one inch gas line and 3 psi gas pressure, a ¼ inch copper bypass line is clearly not a one inch line and can adversely change the required gas pressure. Use of these lines may also contribute to incomplete combustion thus causing a carbon monoxide build up. A 10 burner range requiring a one inch gas line, but utilizing a ¼ inch copper bypass line, can have 6 to 8 burners operating however, it would be questionable if theses burners are functioning correctly. As in this situation where the ventilating hood would be off and gas is being supplied via the bypass line, any products of combustion be it complete or incomplete would not be properly ventilated from the building.

DEPT. OF HOUSING AND COMMUNITY DEVELOPMENT REGULATORY CHANGE FORM

(Use this form to submit changes to building and fire codes)

Address to submit to: DHCD, the Jackson Center 501 North Second Street Richmond, VA 23219-1321 Tel. No. (804) 371 – 7150 Fax No. (804) 371 – 7092 Email: bhcd@dhcd.state.va.us	1/14/07	Document No. _____ Committee Action: _____ BHCD Action: _____

Submitted by: Guy Tomberlin, Fairfax County

Representing: VA Plumbing and Mechanical Inspectors Association (VPMIA)

Address:12055 Government Center Pkwy., Suite 630 Fairfax, VA 22030 Phone No.:703-324-1611

Regulation Title: USBC Part I New Construction - IFGC Technical Amendments Submitted by J D Mitchell.

Section No(s): Section 503.3.4

Supporting statement of explanation:

SECTION 505 (IFGC)
DIRECT-VENT, INTEGRAL VENT,
MECHANICAL VENT AND
VENTILATION/EXHAUST HOOD VENTING

505.1 General. The installation of direct-vent and integral vent appliances shall be in accordance with Section 503. Mechanical venting systems and exhaust hood venting systems shall be designed and installed in accordance with Section 503.

505.1.1 Commercial cooking appliances vented by exhaust hoods. Where commercial cooking appliances are vented by means of the Type I or II kitchen exhaust hood system that serves such appliances, the exhaust system shall be fan powered and the appliances shall be interlocked with the exhaust hood system to prevent appliance operation when the exhaust hood system is not operating. Where a solenoid valve is installed in the gas piping as part of an interlock system, gas piping shall not be installed to bypass such valve. Dampers shall not be installed in the exhaust system.

Exception: An interlock between the cooking appliance(s) and the exhaust hood system shall not be required where heat sensors or other approved methods automatically activate the exhaust hood system when cooking operations occur.

This is the new text included in the 2006 International Fuel Gas Code (IFGC). It appears to adequately address the proponents concerns. The proponent's proposal and the new IFGC text actually achieve the same net effect. They both require all appliances to be interlocked and they both prohibit by-pass piping around solenoids. However, by using the newly worded text of Section 505.1.1 (which includes reference to Section 503) of 2006 IFGC eliminates the need for the proposed technical amendment to the USBC IFGC requirements.

VIRGINIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
DIVISION OF BUILDING AND FIRE REGULATION

2006 Code Change Cycle – Code Change Evaluation Form

USBC – Virginia Construction Code
Code Change No. C-2901.1

Nature of Change: (text is on code change form)

To reference the Virginia Department of Environmental Quality (DEQ) as well as the Virginia Department of Health (VDOH) for approval of functional design.

Proponent: DHCD Staff

Staff Comments:

Due to changes in state law, the approval of sewage treatment systems is now split between DEQ and VDOH depending on the type and location of the system. DHCD has entered into a new Memorandum of Agreement with DEQ outlining the point of demarcation between its regulations and the USBC. This staff proposal changes the current text in the International Residential Code and the International Mechanical Code to reflect the new arrangement. The change was discussed in Workgroup 1 and at the April 9, 2007 Stakeholder's meeting and is recommended for consensus since it only reflects changes in the law.

Codes and Standards Committee Action:

_____ Approve as presented. _____ Disapprove.

_____ Approve as modified (specify):

_____ Carry over to next cycle. _____ Other (specify):

VIRGINIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
CODE CHANGE FORM

Address to submit to: DHCD, The Jackson Center 501 North Second Street Richmond, VA 23219-1321 Tel. No. (804) 371 – 7150 Fax No. (804) 371 – 7092 Email: bhcd@dhcd.virginia.gov		Document No. C-2901.1 Committee Action: _____ BHCD Action: _____

Submitted by: Technical Assistance Services Office, Division of Building and Fire Regulation, DHCD

Address: _____ Phone No. _____

Regulation Title: Virginia Construction Code Section No(s): IRC P2602.1 and IPC 2901.1

Proposed Change:

Change IRC Section P2602.1 and IPC Section 2901.1 as follows:

P2602.1 General. The water and drainage system of any building or premises where plumbing fixtures are installed shall be connected to a public or private water-supply and a public or private sewer system. ~~Where applicable,~~ As provided for in Section 103.11 for functional design, water supply sources and sewage disposal systems ~~shall be~~ are regulated and approved by the Virginia Department of Health and the Virginia Department of Environmental Quality .

Note: See also the Memorandums of Agreement in the "Related Laws Package" which is available from DHCD.

2901.1 Scope. The provisions of this chapter and the International Plumbing Code shall govern the design and installation of all plumbing systems and equipment, except that as provided for in Section 103.11 for functional design, water supply sources and sewage disposal systems are regulated and approved by the Virginia Department of Health and the Virginia Department of Environmental Quality . The approval of pumping and electrical equipment associated with such water supply sources and sewage disposal systems shall, however, be the responsibility of the building official.

Note: See also the Memorandums of Agreement in the "Related Laws Package" which is available from DHCD.

Supporting Statement:

This change is to clarify that due to recent changes in state law, both the Virginia Department of Health and the Department of Environmental Quality are involved in the functional design of water supply and sewage disposal systems. The added note is to reflect new Memorandums of Agreement between those agencies and the Department of Housing and Community Development which address the coordination of the regulations.

VIRGINIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
DIVISION OF BUILDING AND FIRE REGULATION

2006 Code Change Cycle – Code Change Evaluation Form

USBC – Virginia Construction Code
Code Change No. C-2901.1.1)

Nature of Change: (text is on code change form)

To require a copper tracer wire to be installed in the same trench as nonmetallic sewer pipe for use in locating the sewer pipe in the future.

Proponent: Virginia State Corporation Commission

Staff Comments:

While this is already a requirement for piping installed by or for a public utility under the "Ms. Utility" law, it is not clear whether the law applies to sewer pipes installed from the end of the public utility piping to a building or structure. This proposal would close that loophole. The code change was conceptually discussed at Workgroup 3 meetings and received a large degree of consensus. The actual proposal was not received in time to be reviewed by the workgroup. One of the differences between this proposal and the Ms. Utility law is that the law only requires that a means of locating the pipes be provided. It does not specify a tracer wire. Concerns were raised about cost in the Workgroup 3 meetings.

Staff notes that the proposed language requires the building official to approve the method of termination of the tracer wire at each end and to determine whether a heavier gauge wire is required. Generally, a code provision will specify installation practices more clearly to avoid subjective decisions varying from locality to locality.

Codes and Standards Committee Action:

_____ Approve as presented. _____ Disapprove.

_____ Approve as modified (specify):

_____ Carry over to next cycle. _____ Other (specify):

DEPT. OF HOUSING AND COMMUNITY DEVELOPMENT REGULATORY CHANGE FORM

(Use this form to submit changes to building and fire codes)

Address to submit to: DHCD, the Jackson Center 501 North Second Street Richmond, VA 23219-1321 Tel. No. (804) 371 – 7150 Fax No. (804) 371 – 7092 Email: bhcd@dhcd.state.va.us	8/10/07	Document No. C-2901.1.1 Committee Action: _____ BHCD Action: _____

Submitted by: Massoud Tahamtani, Chairman

Representing: The Virginia Underground Utility Damage Prevention Advisory Committee (appointed in accordance with § 56-265.31A) Virginia State Corporation Commission

Address: 1300 East Main Street, Richmond, Virginia 23219 Phone No.: 804-371-9264

Regulation Title: Commonwealth of Virginia Uniform Statewide Building Code

Section No(s): Chapter 29 Plumbing Systems

Proposed Change:

§ - Any nonmetallic sewer pipe installed underground will be installed with an insulated copper tracer wire. The wire will be installed on or in close proximity to the nonmetallic sewer pipe. The ends of the tracer wire should terminate as follows: The end closest to the subject building will terminate to electronic ground or above ground in a manner approved by the Building Official. [1] The end furthest from the subject building and closest to the discharge connection must terminate above ground in a manner approved by the Building Official. The tracer wire insulation type shall be suitable for direct burial. The tracer wire size shall not be less than 18AWG, but heavier gauge wire will be at the discretion of and in a manner approved by the Building Official. Septic drain fields are exempt from these requirements.

1- Expert research has shown having both ends exposed make it possible for a locator to visually locate one end and ground it, then connect the electronic equipment to the other exposed end and accurately trace the area between. In theory this works well; however, in real life, when a locator is called, finding the end closest to the subject building is often not possible. Accordingly, ***the preferred method is to ground the end closest to the building at installation.*** *(Assuming the end closest to the discharge point is accessible, via a cleanout, with wire wrapped around it and/or otherwise readily identifiable.) Grounding the end closest to the building at installation will also allow for Electronic Inductive Locating, thereby eliminating the otherwise required wire hook-up.*

Supporting Statement:

Having the ability to locate nonmetallic sewer underground utility lines is a matter of public safety. Locatable sewer facilities will enable utility line locators to locate and then mark the approximate horizontal location of the sewer lines on the ground in response to a notice of proposed excavation issued by Miss Utility of Virginia. This is required by the Virginia Underground Utility Damage Prevention Act ("Act"), § 56-265.14 et seq. of the Code of Virginia. Nonmetallic sewer lines frequently are not located because they are not installed in a manner to make them locatable as required by §56-265.20:1 of the Act. This section states, in part, "...any plastic or other nonmetallic utility lines installed underground on and after July 1, 2002, shall be installed in such a manner as to be locatable...."

Not being able to mark the approximate horizontal location of sewer facilities poses a serious public safety threat when trenchless excavation (directional drilling, impact moles, etc.) is used for installing other underground utility lines. More and more utilities and their contractors install underground utility lines using trenchless technology. Before using such technology, excavators are required to call Miss Utility (@811) and request the marking of underground utility lines in the area of excavation. After existing utility lines are marked, excavators are required to hand dig and find these utility lines before they bore over or under the lines. If sewer lines are not locatable and therefore are not marked, the excavators may end up "boring" through the sewer lines and leaving a utility line such as gas piping, electric or telecommunication cables inside the sewer line without even knowing it.

The presence of a utility line in a sewer facility can go unnoticed for months or even years, but would in all likelihood result in a sewer blockage. Mechanical equipment used by plumbers or operators to remove such blockages can rupture the gas lines, or cut the power or telecommunications lines. Hitting an electric cable poses a deadly threat to the operator of the cleaning tool. Rupturing a gas line results in migration of gas through the sewer facilities back to the structures and may cause a major accident involving death, injury and significant property damage.

Amending the appropriate section of the Virginia Statewide Building Code to require that sewer laterals put in by plumbers be locatable will improve public safety and is for public good. The local building inspectors would assist in making sure that such facilities are locatable. Obviously, this change would be for new facilities.

Comments regarding code changes.

1. Comment:

Why is the proposed language only applicable to non-metallic sewer lines. What about non-metallic domestic water piping, private gas piping, and non-metallic storm drainage piping (including PVC and concrete piping)? As a matter of practicality, several other thoughts play into mind here:

1. In this day and age, any plumber can tell you that anything copper is "golden" in the hands of a thief, so I wonder how, when I cannot even keep installed copper piping systems from being cut out of buildings, a loose copper tracer wire will survive "outside" as it were.
2. Why exempt septic drain fields? If they are cut, the effect can be just as deleterious to health as any other sewer piping system.
3. As an alternative - several manufacturer's make a metallic foil type "warning tape" with a suggested installation method of installing it just beneath the ground surface where it can usually be easily located by a standard metal detector. Even if it is not detected beforehand, if the warning tape is installed just beneath the ground surface, all but a most aggressive excavator will be able to know that a buried line is below as soon as he cuts into the warning tape.....and the foil material of the tape is generally worthless as far as any scrap value, so there is no impetus for a thief to steal such a device.

Hope these thoughts provide some fuel for a lively debate!

Bob Kirby

D. E. KIRBY, INC.
MECHANICAL CONTRACTORS
PHONE (757) 488-5065
FAX (757) 465-2781
E-MAIL: rmkirby@dekirby.com

ROBERT M. KIRBY, P.E.
PRESIDENT

3921 GARWOOD AVENUE
PORTSMOUTH, VA 23701

2. this is nuts.another rule to add unnecessary cost to a house.we cannot make everything underground traceable and markable.

john rorrer

3. My only comment on the code change is they should say exactly what wire size to use and leave out the "heavier gauge if required by the building official". That way, you would know exactly what is required as you go into different municipalities, rather than "at the descretion (mercy) of the local building official".

Thanks,

Wayne Gauldin
Valley Mechanical Contractors

Hodge, Vernon

From: Rodgers, Emory
Sent: Tuesday, August 21, 2007 4:58 PM
To: Jim Steinle
Cc: Hodge, Vernon; Tomberlin, Guy; Eubank, Paula; Frank Hudik
Subject: RE: Chapter 29 Plumbing Systems Proposed Change

Jim: Thanks and very helpful suggestions and feedback.

From: Jim Steinle [mailto:Jim@atomicplumbing.com]
Sent: Tuesday, August 21, 2007 4:13 PM
To: Rodgers, Emory
Subject: Chapter 29 Plumbing Systems Proposed Change

August 16, 2007

DHCD The Jackson Center
501 North Second Street
Richmond, Virginia 23219-1321
Telephone (804) 371-7150
Fax: (804) 371-7092

Re: Chapter 29 Plumbing Systems Proposed Change

To Mr. Emory Rodgers:

I agree whole heartily about your supporting statement and the information regarding sewer lines that are being penetrated when boring or trenchless technology is being used, and I think this is a major problem that needs to be addressed. As a Plumbing Contractor I have come across 4 or 5 situations where we have found a gas line that has bored or pushed through a sewer line. However, there are other ways of locating a non-metallic sewer line; you could run a camera down the line, and trace out its path, or you could run metal fish tape or a metal sewer snake down the line and trace it that way. I agree a trace wire would be the best and easiest way, but you must come up with a standardized way to make the connection, instead of leaving it up to the Building Official. Someone must decide on or develop a procedure that everyone will follow when it comes to terminating the tracer wire. This way everyone will handle it in the same manner. If you have any questions regarding my thoughts on the proposed change, please feel free to call me at (757) 464-2934.

Sincerely,

James S. Steinle
President

James S. Steinle

Atomic Plumbing & Drain Cleaning
1377 London Bridge Road; Va. Beach, VA 23453
Phone: (757) 464-2934 Fax: (757) 363-8403
Email: jim@atomicplumbing.com

VIRGINIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
DIVISION OF BUILDING AND FIRE REGULATION

2006 Code Change Cycle – Code Change Evaluation Form

USBC – Virginia Construction Code
Code Change No. C-2901.1(P310.4)

Nature of Change: (text is on code change form)

To clarify the provisions in the International Plumbing Code (IPC) relative to the use of water closet compartments in jail or prison facilities.

Proponent: Virginia Department of Corrections (DOC)

Staff Comments:

This proposal was not received in time to be considered by the workgroups used in this code change cycle, however, staff did meet with DOC and the Virginia Department of General Services (DGS), the state agency responsible for the oversight of construction of state prison facilities, and the change was considered. Both DGS and staff suggested this change was not necessary as inmate toilet facilities are not facilities for the public or employees. DOC stated that this issue had come up in the design of a number of jail facilities, which are regulated by local building officials. DOC has submitted this change to the International Code Council for the 2009 IBC.

Codes and Standards Committee Action:

_____ Approve as presented. _____ Disapprove.

_____ Approve as modified (specify):

_____ Carry over to next cycle. _____ Other (specify):

VIRGINIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
CODE CHANGE FORM

Address to submit to: DHCD, The Jackson Center 501 North Second Street Richmond, VA 23219-1321 Tel. No. (804) 371 – 7150 Fax No. (804) 371 – 7092 Email: bhcd@dhcd.virginia.gov		Document No. C-2901.1 (P310.4) Committee Action: _____ BHCD Action: _____

Submitted by: A. Brooks Ballard Representing: Va. Dept of Corrections

Address: A&D Unit, 6900 Atmore Drive, Richmond, VA 23225 Phone No. (804) 674-3102 ext. 1221

Regulation Title: VUSBC, International Plumbing Code 2006 Section No(s): P310.4

Proposed Change:

P310.4 Water closet compartment. Each water closet utilized by the public or employees shall occupy a separate compartment with walls or partitions and a door enclosing the fixtures to ensure privacy.

Exceptions:

1. Water closet …door.

2. Toilet rooms…compartment.

3. Water closet compartments or partitions shall not be required in toilet facilities for inmates in I-3 occupancies.

Supporting Statement:

Occupants of an I-3 facility must be watched closely to assure that they do not harm others or themselves. This clarification is needed to assure supervision and sightlines needed for security in detention and correctional facilities is allowed to be maintained.

VIRGINIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
DIVISION OF BUILDING AND FIRE REGULATION

2006 Code Change Cycle – Code Change Evaluation Form

USBC – Virginia Construction Code
Code Change No. C-2901.1(P403.1)

Nature of Change: (text is on code change form)

To clarify the provisions in the International Plumbing Code (IPC) relative to employee toilet facilities in jails or prisons.

Proponent: Virginia Department of Corrections (DOC)

Staff Comments:

This proposal was not received in time to be considered by the workgroups used in this code change cycle, however, staff did meet with DOC and the Virginia Department of General Services (DGS), the state agency responsible for the oversight of construction of state prison facilities, and the change was considered. DGS suggested this change was not necessary. Staff notes that the table could be read to not require employee facilities at all, but footnote "b" suggests they are required. The proposal uses the number of employee facilities established in the table for Group I-2 facilities. DOC has submitted this change to the International Code Council for the 2009 IBC.

Codes and Standards Committee Action:

_____ Approve as presented. _____ Disapprove.

_____ Approve as modified (specify):

_____ Carry over to next cycle. _____ Other (specify):

VIRGINIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
CODE CHANGE FORM

Address to submit to: DHCD, The Jackson Center 501 North Second Street Richmond, VA 23219-1321 Tel. No. (804) 371 – 7150 Fax No. (804) 371 – 7092 Email: bhcd@dhcd.virginia.gov		Document No. C-2901.1 (P403.1) Committee Action: _____ BHCD Action: _____

Submitted by: A. Brooks Ballard Representing: Va. Dept of Corrections

Address: A&D Unit, 6900 Atmore Drive, Richmond, VA 23225 Phone No. (804) 674-3102 ext. 1221

Regulation Title: VUSBC, International Plumbing Code 2006 Section No(s): Table P403.1

Proposed Change:
(addition to current text)
Table P403.1 Minimum Number of Required Plumbing Fixtures

Occupancy	Description	Water Closets	Lavatories	Drinking Fountains
I-3	Reformitories, detention centers, and correctional centers	1 per 15	1 per 15	1 per 100
I-3	Employees	1 per 25	1 per 35	1 per 100
I-4	Adult day care and Child care	1 per 15		1 per 100

Supporting Statement:

This change brings consistency with I-2 in Table P403.1 for employees in I-3 use group.

VIRGINIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
DIVISION OF BUILDING AND FIRE REGULATION

2006 Code Change Cycle – Code Change Evaluation Form

USBC – Virginia Construction Code
Code Change No. C-2901.1(P909.1)

Nature of Change: (text is on code change form)

To extend the wet venting provisions of the International Plumbing Code (IPC) and the International Residential Code (IRC) to permit any number of fixtures on a floor to be wet vented instead of only those within two bathroom groups.

Proponent: County of Henrico

Staff Comments:

Staff notes that the 2006 IRC has already been changed to match the proposal for vertical wet vents (Section P3108.4), so that part of the change is unnecessary. It would appear that the proposal would permit all fixtures on a floor to be vented using a horizontal wet vent, regardless of the size of the floor or the number of fixtures. The proponent does not provide the reasoning which limits the current provisions to only two bathroom groups.

The proposal has not been submitted to the national level for the 2009 I-Codes and was not received in time for review by the workgroups used in this code change cycle.

Codes and Standards Committee Action:

_____ Approve as presented. _____ Disapprove.

_____ Approve as modified (specify):

_____ Carry over to next cycle. _____ Other (specify):

DEPT. OF HOUSING AND COMMUNITY DEVELOPMENT REGULATORY CHANGE FORM

(Use this form to submit changes to building and fire codes)

Address to submit to:

DHCD, the Jackson Center
501 North Second Street
Richmond, VA 23219-1321

Tel. No. (804) 371 – 7150
Fax No. (804) 371 – 7092
Email: bhcd@dhcd.state.va.us

Document No. C-2901.1 (P909.1)

Committee Action: _____

BHCD Action: _____

Submitted by: Charles E. Gerbe Representing: County of Henrico

Address: P.O. Box 27032 Richmond, VA 23273 Phone No.: (804) 501-4369

Regulation Title: IPC/IRC Section No(s): 909.1, 909.1.1, 909.2, P3108.1, P3108.4, P3108.2

Proposed Change:

(See attached)

Supporting Statement:

(See attached)

IPC/ IRC

909.1 Horizontal wet vent permitted. (IRC P3108.1) Any combination of fixtures ~~within two bathroom groups~~ located on the same floor level is permitted to be vented by a horizontal wet vent. The wet vent shall be considered the vent for the fixtures and shall extend from the connection of the dry vent along the direction of the flow in the drain pipe to the most downstream fixture drain connection to the horizontal branch drain. ~~Only the fixtures within the bathroom groups shall connect to the wet vented horizontal branch drain. Any additional fixtures shall discharge downstream of the horizontal wet vent~~.

909.1.1 Vertical wet vent permitted. (IRC P3108.4) Any combination of fixtures ~~within two bathroom groups~~ located on the same floor level is permitted to be vented by a vertical wet vent. The vertical wet vent shall be considered the vent for the fixtures and shall extend from the connection to the dry vent down to the lowest fixture drain connection. Each wet-vented fixture shall connect independently to the vertical wet vent. Water closet drains shall connect at the same elevation. Other fixture drains shall connect above or at the same elevation as the water closet fixture drains. The dry vent connection to the vertical wet vent shall be an individual or common vent serving one or two fixtures.

909.2 Vent connection. (IRC P3108.2) The dry vent connection to the wet vent shall be an individual vent or common vent ~~to the lavatory, bidet, shower or bathtub~~. In vertical wet-vent systems, the most upstream fixture drain connection shall be a dry-vented fixture drain connection. In horizontal wet-vent systems, not more than one wet-vented fixture drain shall discharge upstream of the dry-vented fixture drain connection.

Reason: Wet venting is a type of venting system that works with more than just bathroom fixtures. A drinking fountain or a service sink tied into a lavatory that is wet venting a water closet will work fine, as long as the pipes are sized properly per the wet vent table. The problem with the previous example is it would not be allowed because some of the fixtures were not bathroom fixtures. The reality is the water flowing through the pipe doesn't know where it came from and the system will either work right or not. This change would allow more flexibility in design and installation without compromising the integrity of the trap. Federal water conservation guidelines are in effect and less water than ever is being discharged through

plumbing systems, which causes the question for more than this section of code to be re-examined for revision.

VIRGINIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
DIVISION OF BUILDING AND FIRE REGULATION

2006 Code Change Cycle – Code Change Evaluation Form

USBC – Virginia Construction Code
Code Change No. C-3501.1

Nature of Change: (text is on code change form)

To update a referenced standard in the International Building Code (IBC) to eliminate a conflict with another referenced standard.

Proponent: Portland Cement Association

Staff Comments:

The 2006 IBC references the American Concrete Institute's Standard No. 318-2005 for building code requirements for structural concrete. Within that reference standard is a further reference to the American Society of Testing and Materials (ASTM) Standard No. C31-2003a for making and curing concrete test specimens in the field. The IBC also separately references ASTM C31, but references the 1998 edition instead of the 2003a edition. This change would simply correct the reference in the IBC to the 2003a edition of ASTM C31. The change was considered by Workgroups 2 and 3 and is recommended to move forward as consensus since the change was approved at the national level and is contained in the 2007 Supplement to the IBC.

Codes and Standards Committee Action:

_____ Approve as presented. _____ Disapprove.

_____ Approve as modified (specify):

_____ Carry over to next cycle. _____ Other (specify):

C-350.1

Hodge, Vernon

From: Joseph J. Messersmith, Jr. [jjmessersmith@comcast.net]
Sent: Tuesday, April 17, 2007 11:12 AM
To: Hodge, Vernon
Cc: Rodgers, Emory; Eubank, Paula; Stephen Szoke; Steve Skalko
Subject: Re: FW: Code Change Received
Attachments: C31C31M.pdf

Vernon:

For many editions of ACI 318, I have putting together the code change to the BOCA code and now the IBC that updates the model code to the latest edition of ACI 318. It has always been my goal to have the standards referenced within the BOCA code and now the IBC to be the same edition that is adopted within ACI 318.

The 2006 IBC references ACI 318-05. Within ACI 318-05, ASTM C31-03a is referenced. For some reason, the 2006 IBC references ASTM C31-98. I do not have time to go through all the code change documentation, etc. to try to determine how this inconsistency happened. In any event, code change S115-06/07 updates C31-98 to C31-03a, the same as referenced in ACI 318-05. The code change was recommended for AM, with the modification having no impact on the update of ASTM C31. There have been no public comments submitted on S115-06/07; therefore, ASTM C31-03a will be referenced in the 2007 or 2008 (whatever they call it) I-codes Supplement, which will bring the 2006 IBC into agreement with ACI 318-05.

I have tried to obtain a copy of ASTM C31-06 to verify the information stated by the proponent of the code change you sent me; however, apparently this has been recently published and our PCA library does not have a copy yet. Based on the code change and statement by the proponent, I assume that the size of cylinder used for acceptance testing for concrete strength can be selected by the testing laboratory preparing the cylinders. Regarding the use of 4 X 8 cylinders for acceptance testing of concrete, C31-03a permits their use provided the engineer of record specifically allows their use. Otherwise, 6 X 12 cylinders are required. See last sentence of Section 6.1 of attached file.

My recommendations follow.

1. When the USBC is revised to adopt the 2006 IBC, it needs to be revised to adopt ASTM C31-03a to be consistent with ACI 318-05 which adopts ASTM C31-03a.
2. If it is the desire of the proponent of the change and other testing laboratories to use 4 X 8 cylinders in lieu of 6 X 12 cylinders, the laboratories can advise engineers of record that ASTM C31-03a permits the engineer of record to revise their specifications to specifically permit the use of 4 X 8 cylinders for acceptance testing of concrete strength.

I'm attaching a pdf file of ASTM C31-03a.

If you have questions, please contact me.

Jim

At 04:17 PM 4/16/2007 , Hodge, Vernon wrote:

381

Jim, Emory asked that I forward this proposal to you for your comments. It will be looked at by one of our workgroups.

From: Rodgers, Emory
Sent: Friday, April 13, 2007 7:56 PM
To: Hodge, Vernon
Cc: Eubank, Paula; Dean, Glenn
Subject: RE: Code Change Received

Send to John Catlett and Ray Pylant as bet used now because of local policies with Wacel. check to see if it is submitted to ICC for 2009 and if not ask them to find out why. copy Jim messersmith too as PCA is part of the process on the standard. Here we go with now two folks wanting to use standards being submitted in the 2009 IBC. This will be work group 2 item.

From: Hodge, Vernon
Sent: Fri 4/13/2007 2:25 PM
To: Rodgers, Emory
Cc: Eubank, Paula; Dean, Glenn
Subject: Code Change Received

Attached.

****

May 6-12, 2007 is National Building Safety Week. This year's theme is "Building Smarter.....for Disasters and Everyday Life." To participate in Building Safety Week activities and efforts to improve building safety, visit: www.ICCsafe.org. Follow the link to Public Safety and select Building Safety Week.

Designation: C 31/C 31M – 03a

Standard Practice for Making and Curing Concrete Test Specimens in the Field[1]

This standard is issued under the fixed designation C 31/C 31M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This practice covers procedures for making and curing cylinder and beam specimens from representative samples of fresh concrete for a construction project.

1.2 The concrete used to make the molded specimens shall be sampled after all on-site adjustments have been made to the mixture proportions, including the addition of mix water and admixtures. This practice is not satisfactory for making specimens from concrete not having measurable slump or requiring other sizes or shapes of specimens.

1.3 The values stated in either inch-pound units or SI units shall be regarded separately as standard. The SI units are shown in brackets. The values stated may not be exact equivalents; therefore each system must be used independently of the other. Combining values from the two units may result in nonconformance.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.5 The text of this standard references notes which provide explanatory material. These notes shall not be considered as requirements of the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

C 125 Terminology Relating to Concrete and Concrete Aggregates[2]

C 138/C 138M Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete[2]

C 143/C 143M Test Method for Slump of Hydraulic Cement Concrete[2]

C 172 Practice for Sampling Freshly Mixed Concrete[2]

C 173/C 173M Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method[2]

C 192/C 192M Practice for Making and Curing Concrete Test Specimens in the Laboratory[2]

C 231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method[2]

C 330 Specification for Lightweight Aggregates for Structural Concrete[2]

C 403/C 403M Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance[2]

C 470/C 470M Specification for Molds for Forming Concrete Test Cylinders Vertically[2]

C 511 Specification for Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes[3]

C 617 Practice for Capping Cylindrical Concrete Specimens[2]

C 1064/C 1064M Test Method for Temperature of Freshly Mixed Portland Cement Concrete[2]

2.2 *American Concrete Institute Publication:*[4]

CP-1 Concrete Field Testing Technician, Grade I

309R Guide for Consolidation of Concrete

3. Terminology

3.1 For definitions of terms used in this practice, refer to Terminology C 125.

4. Significance and Use

4.1 This practice provides standardized requirements for making, curing, protecting, and transporting concrete test specimens under field conditions.

4.2 If the specimens are made and standard cured, as stipulated herein, the resulting strength test data when the specimens are tested are able to be used for the following purposes:

4.2.1 Acceptance testing for specified strength,

4.2.2 Checking adequacy of mixture proportions for strength, and

[1] This practice is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.61 on Testing for Strength.

Current edition approved Feb. 10, 2003. Published April 2003. Originally approved in 1920. Last previous edition approved in 2003 as C 31/C 31M-03.

[2] *Annual Book of ASTM Standards*, Vol 04.02.

[3] *Annual Book of ASTM Standards*, Vol 04.01.

[4] Available from American Concrete Institute, P.O. Box 9094, Farmington Hills, MI 48333-9094.

4.2.3 Quality control.

4.3 If the specimens are made and field cured, as stipulated herein, the resulting strength test data when the specimens are tested are able to be used for the following purposes:

4.3.1 Determination of whether a structure is capable of being put in service,

4.3.2 Comparison with test results of standard cured specimens or with test results from various in-place test methods,

4.3.3 Adequacy of curing and protection of concrete in the structure, or

4.3.4 Form or shoring removal time requirements.

5. Apparatus

5.1 *Molds, General*— Molds for specimens or fastenings thereto in contact with the concrete shall be made of steel, cast iron, or other nonabsorbent material, nonreactive with concrete containing portland or other hydraulic cements. Molds shall hold their dimensions and shape under all conditions of use. Molds shall be watertight during use as judged by their ability to hold water poured into them. Provisions for tests of water leakage are given in the Test Methods for Elongation, Absorption, and Water Leakage section of Specification C 470/C 470M. A suitable sealant, such as heavy grease, modeling clay, or microcrystalline wax shall be used where necessary to prevent leakage through the joints. Positive means shall be provided to hold base plates firmly to the molds. Reusable molds shall be lightly coated with mineral oil or a suitable nonreactive form release material before use.

5.2 *Cylinder Molds*— Molds for casting concrete test specimens shall conform to the requirements of Specification C 470/C 470M.

5.3 *Beam Molds*—Beam molds shall be of the shape and dimensions required to produce the specimens stipulated in 6.2. The inside surfaces of the molds shall be smooth. The sides, bottom, and ends shall be at right angles to each other and shall be straight and true and free of warpage. Maximum variation from the nominal cross section shall not exceed ⅛ in. [3 mm] for molds with depth or breadth of 6 in. [150 mm] or more. Molds shall produce specimens at least as long but not more than 1/16 in. [2 mm] shorter than the required length in 6.2.

5.4 *Tamping Rod*— A round, straight steel rod with the dimensions conforming to those in Table 1, having the tamping end or both ends rounded to a hemispherical tip of the same diameter as the rod.

5.5 *Vibrators*—Internal vibrators shall be used. The vibrator frequency shall be at least 7000 vibrations per minute [150 Hz] while the vibrator is operating in the concrete. The diameter of a round vibrator shall be no more than one-fourth the diameter of the cylinder mold or one-fourth the width of the beam mold. Other shaped vibrators shall have a perimeter equivalent to the circumference of an appropriate round vibrator. The combined length of the vibrator shaft and vibrating element shall exceed the depth of the section being vibrated by at least 3 in. [75 mm]. The vibrator frequency shall be checked periodically.

TABLE 1 Tamping Rod Requirements

Diameter of Cylinder or Width of Beam in. [mm]	Rod Dimensions[A]	
	Diameter in. [mm]	Length of Rod in. [mm]
<6 [150]	3/8 [10]	12 [300]
6 [150]	5/8 [16]	20 [500]
9 [225]	5/8 [16]	26 [650]

[A] Rod tolerances length ±4 in. [100 mm] and diameter ±1/16 in. [2 mm].

NOTE 1—For information on size and frequency of various vibrators and a method to periodically check vibrator frequency see ACI 309.

5.6 *Mallet*—A mallet with a rubber or rawhide head weighing 1.25 ± 0.50 lb [0.6 ± 0.2 kg] shall be used.

5.7 *Small Tools*— Shovels, hand-held floats, scoops, and a vibrating-reed tachometer shall be provided.

5.8 *Slump Apparatus*— The apparatus for measurement of slump shall conform to the requirements of Test Method C 143/C 143M.

5.9 *Sampling Receptacle*—The receptacle shall be a suitable heavy gage metal pan, wheelbarrow, or flat, clean nonabsorbent board of sufficient capacity to allow easy remixing of the entire sample with a shovel or trowel.

5.10 *Air Content Apparatus*—The apparatus for measuring air content shall conform to the requirements of Test Methods C 173/C 173M or C 231.

5.11 *Temperature Measuring Devices*—The temperature measuring devices shall conform to the applicable requirements of Test Method C 1064/C 1064M.

6. Testing Requirements

6.1 *Cylindrical Specimens*—Compressive or splitting tensile strength specimens shall be cylinders cast and allowed to set in an upright position. The length shall be twice the diameter. The cylinder diameter shall be at least 3 times the nominal maximum size of the coarse aggregate. When the nominal maximum size of the coarse aggregate exceeds 2 in. [50 mm], the concrete sample shall be treated by wet sieving through a 2-in. [50-mm] sieve as described in Practice C 172. For acceptance testing for specified compressive strength, cylinders shall be 6 by 12 in. [150 by 300 mm] or when specified 4 × 8 in. [100 × 200 mm] (Note 2).

NOTE 2—When molds in SI units are required and not available, equivalent inch-pound unit size mold should be permitted.

6.2 *Beam Specimens*— Flexural strength specimens shall be beams of concrete cast and hardened in the horizontal position. The length shall be at least 2 in. [50 mm] greater than three times the depth as tested. The ratio of width to depth as molded shall not exceed 1.5. The standard beam shall be 6 by 6 in. [150 by 150 mm] in cross section, and shall be used for concrete with nominal maximum size coarse aggregate up to 2 in. [50 mm]. When the nominal maximum size of the coarse aggregate exceeds 2 in. [50 mm], the smaller cross sectional dimension of the beam shall be at least three times the nominal maximum size of the coarse aggregate. Unless required by project specifications, beams made in the field shall not have a width or depth of less than 6 in. [150 mm].

6.3 *Field Technicians*—The field technicians making and curing specimens for acceptance testing shall be certified ACI Field Testing Technicians, Grade I or equivalent. Equivalent personnel certification programs shall include both written and performance examinations, as outlined in ACI CP-1.

7. Sampling Concrete

7.1 The samples used to fabricate test specimens under this standard shall be obtained in accordance with Practice C 172 unless an alternative procedure has been approved.

7.2 Record the identification of the sample with respect to the location of the concrete represented and the time of casting.

8. Slump, Air Content, and Temperature

8.1 *Slump*—Measure and record the slump of each batch of concrete from which specimens are made immediately after remixing in the receptacle, as required in Test Method C 143/C 143M.

8.2 *Air Content*— Determine and record the air content in accordance with either Test Method C 173/C 173M or Test Method C 231. The concrete used in performing the air content test shall not be used in fabricating test specimens.

8.3 *Temperature*— Determine and record the temperature in accordance with Test Method C 1064/C 1064M.

NOTE 3—Some specifications may require the measurement of the unit weight of concrete. The volume of concrete produced per batch may be desired on some projects. Also, additional information on the air content measurements may be desired. Test Method C 138/C 138M is used to measure the unit weight, yield, and gravimetric air content of freshly mixed concrete.

9. Molding Specimens

9.1 *Place of Molding*— Mold specimens promptly on a level, rigid surface, free of vibration and other disturbances, at a place as near as practicable to the location where they are to be stored.

9.2 *Casting Cylinders*—Select the proper tamping rod from 5.4 and Table 1 or the proper vibrator from 5.5. Determine the method of consolidation from Table 2, unless another method is specified. If the method of consolidation is rodding, determine molding requirements from Table 3. If the method of consolidation is vibration, determine molding requirements from Table 4. Select a small tool of a size and shape large enough so each amount of concrete obtained from the sampling receptacle will be representative and small enough so concrete is not lost when being placed in the mold. While placing the concrete in the mold, move the small tool around the perimeter of the mold opening to ensure an even distribution of the concrete and minimize segregation. Each layer of concrete shall be consolidated as required. In placing the final layer, add an amount of concrete that will fill the mold after consolidation.

9.3 *Casting Beams*— Select the proper tamping rod from 5.4 and Table 1 or proper vibrator from 5.5. Determine the method of consolidation from Table 2, unless another method is specified. If the method of consolidation is rodding, determine the molding requirements from Table 3. If the method of consolidation is vibration, determine the molding requirements from Table 4. Determine the number of roddings per layer, one for each 2 in.^{2} [14 cm^2] of the top surface area of the beam. Select a small tool, of the size and shape large enough so each amount of concrete obtained from the sampling receptacle is representative and small enough so concrete is not lost when placed in the mold. Each layer shall be consolidated as required. In placing the final layer, add an amount of concrete that will fill the mold after consolidation. Place the concrete so that it is uniformly distributed within each layer with a minimum of segregation.

TABLE 2 Method of Consolidation Requirements

Slump in. (mm)	Method of Consolidation
≥ 1 [25]	rodding or vibration
< 1 [25]	vibration

TABLE 3 Molding Requirements by Rodding

Specimen Type and Size	Number of Layers of Approximately Equal Depth	Number of Roddings per Layer
Cylinders:		
Diameter, in. [mm]		
4 [100]	2	25
6 [150]	3	25
9 [225]	4	50
Beams:		
Width, in. [mm]		
6 [150] to 8 [200]	2	see 9.3
>8 [200]	3 or more equal depths, each not to exceed 6 in. [150 mm].	see 9.3

TABLE 4 Molding Requirements by Vibration

Specimen Type and Size	Number of Layers	Number of Vibrator Insertions per Layer	Approximate Depth of Layer, in. [mm]
Cylinders:			
Diameter, in. [mm]			
4 [100]	2	1	one-half depth of specimen
6 [150]	2	2	one-half depth of specimen
9 [225]	2	4	one-half depth of specimen
Beams:			
Width, in. [mm]			
6 [150] to 8 [200]	1	see 9.4.2	depth of specimen
over 8 [200]	2 or more	see 9.4.2	8 [200] as near as practicable

9.4 *Consolidation*— The methods of consolidation for this practice are rodding or internal vibration.

9.4.1 *Rodding*—Place the concrete in the mold, in the required number of layers of approximately equal volume. Rod each layer with the rounded end of the rod using the required number of roddings. Rod the bottom layer throughout its depth. Distribute the roddings uniformly over the cross section of the mold. For each upper layer, allow the rod to penetrate through the layer being rodded and into the layer below approximately 1 in. [25 mm]. After each layer is rodded, tap the outsides of the mold lightly 10 to 15 times with the mallet, to close any holes left by rodding and to release any large air bubbles that may have been trapped. Use an open hand to tap light-gage single-use cylinder molds which are susceptible to damage if tapped with a mallet. After tapping, spade each layer of the concrete along the sides and ends of beam molds with a trowel or other suitable tool. Underfilled molds shall be adjusted with representative concrete during consolidation of the top layer. Overfilled molds shall have excess concrete removed.

9.4.2 *Vibration*—Maintain a uniform duration of vibration for the particular kind of concrete, vibrator, and specimen mold involved. The duration of vibration required will depend upon the workability of the concrete and the effectiveness of the vibrator. Usually sufficient vibration has been applied as soon as the surface of the concrete has become relatively smooth and large air bubbles cease to break through the top surface. Continue vibration only long enough to achieve proper consolidation of the concrete (see Note 4). Fill the molds and vibrate in the required number of approximately equal layers. Place all the concrete for each layer in the mold before starting vibration of that layer. In compacting the specimen, insert the vibrator slowly and do not allow it to rest on the bottom or sides of the mold. Slowly withdraw the vibrator so that no large air pockets are left in the specimen. When placing the final layer, avoid overfilling by more than ¼ in. [6 mm].

NOTE 4—Generally, no more than 5 s of vibration should be required for each insertion to adequately consolidate concrete with a slump greater than 3 in. [75 mm]. Longer times may be required for lower slump concrete, but the vibration time should rarely have to exceed 10 s per insertion.

9.4.2.1 *Cylinders*—The number of insertions of the vibrator per layer is given in Table 4. When more than one insertion per layer is required distribute the insertion uniformly within each layer. Allow the vibrator to penetrate through the layer being vibrated, and into the layer below, approximately 1 in. [25 mm]. After each layer is vibrated, tap the outsides of the mold at least 10 times with the mallet, to close holes that remain and to release entrapped air voids. Use an open hand to tap cardboard and single-use metal molds that are susceptible to damage if tapped with a mallet.

9.4.2.2 *Beams*—Insert the vibrator at intervals not exceeding 6 in. [150 mm] along the center line of the long dimension of the specimen. For specimens wider than 6 in., use alternating insertions along two lines. Allow the shaft of the vibrator to penetrate into the bottom layer approximately 1 in. (25 mm). After each layer is vibrated, tap the outsides of the mold sharply at least 10 times with the mallet to close holes left by vibrating and to release entrapped air voids.

9.5 *Finishing*—After consolidation, strike off excess concrete from the surface and float or trowel as required. Perform all finishing with the minimum manipulation necessary to produce a flat even surface that is level with the rim or edge of the mold and that has no depressions or projections larger than ⅛ in. [3.3 mm].

9.5.1 *Cylinders*—After consolidation, finish the top surfaces by striking them off with the tamping rod where the consistency of the concrete permits or with a wood float or trowel. If desired, cap the top surface of freshly made cylinders with a thin layer of stiff portland cement paste which is permitted to harden and cure with the specimen. See section on Capping Materials of Practice C 617.

9.5.2 *Beams*—After consolidation of the concrete, use a hand-held float to strike off the top surface to the required tolerance to produce a flat, even surface.

9.6 *Identification*— Mark the specimens to positively identify them and the concrete they represent. Use a method that will not alter the top surface of the concrete. Do not mark the removable caps. Upon removal of the molds, mark the test specimens to retain their identities.

10. Curing

10.1 *Standard Curing*— Standard curing is the curing method used when the specimens are made and cured for the purposes stated in 4.2.

10.1.1 *Storage*—If specimens cannot be molded at the place where they will receive initial curing, immediately after finishing move the specimens to an initial curing place for storage. The supporting surface on which specimens are stored shall be level to within ¼ in. per ft [20 mm per m]. If cylinders in the single use molds are moved, lift and support the cylinders from the bottom of the molds with a large trowel or similar device. If the top surface is marred during movement to place of initial storage, immediately refinish.

10.1.2 *Initial Curing*— Immediately after molding and finishing, the specimens shall be stored for a period up to 48 h in a temperature range from 60 and 80°F [16 and 27°C] and in an environment preventing moisture loss from the specimens. For concrete mixtures with a specified strength of 6000 psi [40 MPa] or greater, the initial curing temperature shall be between 68 and 78°F [20 and 26°C]. Various procedures are capable of being used during the initial curing period to maintain the specified moisture and temperature conditions. An appropriate procedure or combination of procedures shall be used (Note 5). Shield all specimens from the direct sunlight and, if used, radiant heating devices. The storage temperature shall be controlled by use of heating and cooling devices, as necessary. Record the temperature using a maximum-minimum thermometer. If cardboard molds are used, protect the outside surface of the molds from contact with wet burlap or other sources of water.

NOTE 5—A satisfactory moisture environment can be created during the initial curing of the specimens by one or more of the following procedures: (1) immediately immerse molded specimens with plastic lids in water saturated with calcium hydroxide, (2) store in properly constructed wooden boxes or structures, (3) place in damp sand pits, (4) cover with removable plastic lids, (5) place inside plastic bags, or (6) cover with plastic sheets or nonabsorbent plates if provisions are made to avoid drying and damp burlap is used inside the enclosure, but the burlap is prevented from contacting the concrete surfaces. A satisfactory temperature environment can be controlled during the initial curing of the specimens by one or more of the following procedures: (1) use of ventilation, (2) use of ice, (3) use of thermostatically controlled heating or cooling devices, or (4) use of heating methods such as stoves or light bulbs. Other suitable methods may be used provided the requirements limiting specimen storage temperature and moisture loss are met. For concrete mixtures with a specified strength of 6000 psi [40 MPa] or greater, heat generated during the early ages may raise the temperature above the required storage temperature. Immersion in water saturated with calcium hydroxide may be the easiest method to maintain the required storage temperature. When specimens are to be immersed in water saturated with calcium hydroxide, specimens in cardboard molds or other molds that expand when immersed in water should not be used. Early-age strength test results may be lower when stored at 60°F [16°C] and higher when stored at 80°F [27°C]. On the other hand, at later ages, test results may be lower for higher initial storage temperatures.

10.1.3 *Final Curing:*

10.1.3.1 *Cylinders*—Upon completion of initial curing and within 30 min after removing the molds, cure specimens with

free water maintained on their surfaces at all times at a temperature of 73 ± 3°F [23 ± 2°C] using water storage tanks or moist rooms complying with the requirements of Specification C 511, except when capping with sulfur mortar capping compound and immediately prior to testing. When capping with sulfur mortar capping compound, the ends of the cylinder shall be dry enough to preclude the formation of steam or foam pockets under or in cap larger than ¼ in. [6 mm] as described in Practice C 617. For a period not to exceed 3 h immediately prior to test, standard curing temperature is not required provided free moisture is maintained on the cylinders and ambient temperature is between 68 and 86°F [20 and 30°C].

10.1.3.2 *Beams*—Beams are to be cured the same as cylinders (see 10.1.3.1) except that they shall be stored in water saturated with calcium hydroxide at 73 ± 3°F [23 ± 2°C] at least 20 h prior to testing. Drying of the surfaces of the beam shall be prevented between removal from water storage and completion of testing.

NOTE 6—Relatively small amounts of surface drying of flexural specimens can induce tensile stresses in the extreme fibers that will markedly reduce the indicated flexural strength.

10.2 *Field Curing*— Field curing is the curing method used for the specimens made and cured as stated in 4.3.

10.2.1 *Cylinders*—Store cylinders in or on the structure as near to the point of deposit of the concrete represented as possible. Protect all surfaces of the cylinders from the elements in as near as possible the same way as the formed work. Provide the cylinders with the same temperature and moisture environment as the structural work. Test the specimens in the moisture condition resulting from the specified curing treatment. To meet these conditions, specimens made for the purpose of determining when a structure is capable of being put in service shall be removed from the molds at the time of removal of form work.

10.2.2 *Beams*—As nearly as practicable, cure beams in the same manner as the concrete in the structure. At the end of 48 ± 4 h after molding, take the molded specimens to the storage location and remove from the molds. Store specimens representing pavements of slabs on grade by placing them on the ground as molded, with their top surfaces up. Bank the sides and ends of the specimens with earth or sand that shall be kept damp, leaving the top surfaces exposed to the specified curing treatment. Store specimens representing structure concrete as near the point in the structure they represent as possible, and afford them the same temperature protection and moisture environment as the structure. At the end of the curing period leave the specimens in place exposed to the weather in the same manner as the structure. Remove all beam specimens from field storage and store in water saturated with calcium hydroxide at 73 ± 3°F [23 ± 2°C] for 24 ± 4 h immediately before time of testing to ensure uniform moisture condition from specimen to specimen. Observe the precautions given in 10.1.3.2 to guard against drying between time of removal from curing to testing.

10.3 *Structural Lightweight Concrete Curing*—Cure structural lightweight concrete cylinders in accordance with Specification C 330.

11. Transportation of Specimens to Laboratory

11.1 Prior to transporting, cure and protect specimens as required in Section 10. Specimens shall not be transported until at least 8 h after final set. (See Note 7). During transporting, protect the specimens with suitable cushioning material to prevent damage from jarring. During cold weather, protect the specimens from freezing with suitable insulation material. Prevent moisture loss during transportation by wrapping the specimens in plastic, wet burlap, by surrounding them with wet sand, or tight fitting plastic caps on plastic molds. Transportation time shall not exceed 4 h.

NOTE 7—Setting time may be measured by Test Method C 403.

12. Report

12.1 Report the following information to the laboratory that will test the specimens:

12.1.1 Identification number,

12.1.2 Location of concrete represented by the samples,

12.1.3 Date, time and name of individual molding specimens,

12.1.4 Slump, air content, and concrete temperature, test results and results of any other tests on the fresh concrete and any deviations from referenced standard test methods, and

12.1.5 Curing method. For standard curing method, report the initial curing method with maximum and minimum temperatures and final curing method. For field curing method, report the location where stored, manner of protection from the elements, temperature and moisture environment, and time of removal from molds.

13. Keywords

13.1 beams; casting samples; concrete; curing; cylinders; testing

VIRGINIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
DIVISION OF BUILDING AND FIRE REGULATION

2006 Code Change Cycle – Code Change Evaluation Form

USBC – Virginia Construction Code
Code Change Nos. C-3501.1-b1 and C-3501.1-b2

Nature of Changes: (text is on code change form)

To first change (C-3501.1-b1) is to update the elevator standard in the International Building Code (IBC) to the latest available standard which more comprehensively addresses Machine-Room-Less (MRL) elevators. The second change (C-3501.1-b2) is to add specific requirements for MRL elevators to the IBC.

Proponent: Chesterfield County and Fairfax County

Staff Comments:

These proposals were conceptually discussed at the last Workgroup 3 meeting and there was consensus that the USBC should address MRL elevators more clearly. The actual code changes were not submitted in time for further workgroup consideration. A copy of the new ASME A17.1 standard (the 2007 edition) was not provided with the first code change, but will be obtained and be available prior to the final consideration of this change. Concerning the second code change, staff notes that the 2005 A17.1 Supplement is already referenced in the 2006 IBC, so that part of the change is not necessary. The remainder of the change adds requirements related to guards, provisions for machinery removal and hoistway requirements. It is believed that these requirements are not addressed by the 2007 ASME A17.1 standard and would be in addition to its requirements.

Codes and Standards Committee Action:

_____ Approve as presented. _____ Disapprove.

_____ Approve as modified (specify):

_____ Carry over to next cycle. _____ Other (specify):

VIRGINIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
CODE CHANGE FORM

Address to submit to: DHCD, The Jackson Center 501 North Second Street Richmond, VA 23219-1321 Tel. No. (804) 371 – 7150 Fax No. (804) 371 – 7092 Email: bhcd@dhcd.virginia.gov		Document No. C-3501.1-b1 Committee Action: _____ BHCD Action: _____

Submitted by: William Dupler Representing: Chesterfield County

Address: P O Box 40, Chesterfield, Virginia Phone No. (804) 748-1611

Regulation Title: Va. Construction Code Section No(s): Chapter 35 (Referenced Standards)

Proposed Change:

Update the reference in Chapter 35 of the IBC from ASME A17.1-04 with A17.1a-2004 addenda and A17.1S Supplement to ASME A17.1-2007.

Supporting Statement:

The intent of this change is to add a new standard to the code to establish uniform requirements for the installation of MRL (Machine Room-Less) elevators. MRL elevators are manufactured by all major elevator companies and under the current code can only be installed if approved through the modification provisions of the Virginia Construction Code. The newest edition of the ASME elevator standard will provide the minimum safety features and requirements necessary to consider the approval of an MRL elevator without having to use the modification process.

DEPT. OF HOUSING AND COMMUNITY DEVELOPMENT REGULATORY CHANGE FORM

(Use this form to submit changes to building and fire codes)

Address to submit to: DHCD, the Jackson Center 501 North Second Street Richmond, VA 23219-1321 Tel. No. (804) 371 – 7150 Fax No. (804) 371 – 7092 Email: bhcd@dhcd.state.va.us		Document No. C-3501.1 – b2 Committee Action: _____ BHCD Action: _____

Submitted by: Ray Pylant Representing: Fairfax County

Address:12055 Government Center Pkwy., Suite 448 Fairfax, VA 22030 Phone No.:703-324-1910

Regulation Title: _VA Construction Code_____ Section No(s): IBC Sections_3001.2 and new Section 3006.7__

Proposed Change:

3001.2 Referenced standards. Except as otherwise provided for in this code, the design, construction, installation, alteration and repair of elevators and conveying systems and their components shall conform to ASME A17.1, ASME A17.1-2005 S, ASME A90.1, ASME B20.1, ALI ALCTV. In addition ASCE 24 shall apply to construction in flood hazard areas established in Section 1612.3.

Add new IBC/USBC Sections as follows:

3006.7 Machine-room-less designs. Where machine-room-less designs are utilized they shall comply with the provisions of ASME A17.1-2005 S, and incorporate the following:
1. Where the elevator car-top will be used as a work platform, it shall be equipped with permanently installed guards on all open sides. Guards shall be permitted to be of "collapsible" design, but otherwise must conform to all applicable requirements of the International Building Code, 2006 edition, for guards.
2. Where the equipment manufacturer's procedures for machinery removal and replacement depend on overhead structural support or lifting points, such supports or lifting points shall be permanently installed at the time of initial equipment installation.
3. Where the structure within which the elevator will be located is required to be fully sprinklered by this code, the hoistway within which the elevator machine is located shall be regarded as a machine room under NFPA 13, and sprinklers and attendant heat and smoke detectors shall be required therein.

Appendix A add to the list of elevator standards:
ASME A17.1-2005 S edition

Supporting Statement:

This proposal supports and endorses the proposal already submitted that requests the USBC be updated to include the ASME Standard A17.1-2005 S standard which allows "machine-room-less" (MRL) design as an alternative to conventional equipment located within a separate machine room.
The additional text we advocate is to address key life safety features that are not required by all MRL elevator manufacturers, and to clarify that when the elevator machine is situated within the hoistway, the hoistway becomes the machine room.
The first provision recognizes that in the typical MRL design, the elevator machine is mounted inside the hoistway near the top, and the elevator car-top becomes the working platform when this equipment is being inspected, serviced or replaced. Not all manufacturers require guards for the open sides of the car-tops. Providing guards is a standard safety feature for service personal working on elevated surfaces.
The next provision is to facilitate equipment replacement. Permanently installed means for equipment hoisting must be incorporated into the initial installation. It cannot be left up to the service personal who are called to service the equipment. An equipment handling mishap on an elevator car-top at the top of the hoistway is potentially far more serious than one within a standard elevator machine room.
When the elevator machine is placed within the hoistway, the hoistway effectively becomes the machine room. Because NFPA 13 requires sprinklers in elevator machine rooms but usually not within hoistways in fully sprinklered buildings, clarification is needed in this area until such time that appropriate updates to NFPA 13 recognizing MRL technology can be made.

VIRGINIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
DIVISION OF BUILDING AND FIRE REGULATION

2006 Code Change Cycle – Code Change Evaluation Form

USBC – Virginia Construction Code
Code Change No. C-3501.1-c

Nature of Change: (text is on code change form)

To update the concrete test specimen standard in the International Building Code to the newest available standard which permits four-inch test molds instead of the six-inch molds which have been the industry standard for a number of years.

Proponent: Froehling and Robertson, Inc.

Staff Comments:

A copy of the 2006 ASTM C31 standard was provided by the proponent. The 2007 Supplement to the International Building Code updates the standard, but only to the 2003a edition (which is the 2003 addenda to the 1998 edition of the standard). This change was discussed conceptually in a Workgroup 3 meeting prior to the submittal of the code change and concerns were raised relative to the change in the mold size.

Codes and Standards Committee Action:

_____ Approve as presented. _____ Disapprove.

_____ Approve as modified (specify):

_____ Carry over to next cycle. _____ Other (specify):

DEPT. OF HOUSING AND COMMUNITY DEVELOPMENT REGULATORY CHANGE FORM

(Use this form to submit changes to building and fire codes)

Address to submit to: DHCD, the Jackson Center 501 North Second Street Richmond, VA 23219-1321 Tel. No. (804) 371 – 7150 Fax No. (804) 371 – 7092 Email: bhcd@dhcd.state.va.us		Document No. C-3501.1-C Committee Action: _____ BHCD Action: _____

Submitted by: **C. F. (Chuck) Starnes** Representing: **Froehling & Robertson, Inc**

Address: **3015 Dumbarton Road, Richmond, VA 23228** Phone No.: **804.264.2701, ext. 5008**

Regulation Title: **IBC 2003** Section No(s): **Chapters 17 & 35**

Proposed Change:

The request is made for amendment to code regarding year designation of ASTM Standard. The specific standard in question is ASTM C 31, ***Standard Practice for Making and Curing Concrete Test Specimens in the Field***. In the current IBC, Chapter 35 Referenced Standards, the test standard ASTM C 31 listed is that approved in 1998. We understand that the 2006 Code also lists the 1998 version. The current revision of the standard was issued in September 2006.

Supporting Statement:

ASTM C 31-06 (Paragraph 6.1) contains a change which allows 4x8-inch concrete cylinder mold use in casting acceptance test specimens in lieu of 6x12-inch molds when the maximum coarse aggregate is not larger than 1 ½ inch. This change provides engineering testing laboratories the opportunity to use 4-inch molds in commercial projects. With this change there is concern that there may be confusion and possible conflict due to the Code listing the 1998 Standard. Changes of this type are taken only with much study and review by the Committee and now that it has been finalized and issued we want to incorporate the change in our operation. We feel the conflict with the current and future Code will further delay this action.

The advantages of the smaller molds in the testing of concrete include:

- More effective job site curing. Maintaining constant temperature (60 to 80° F) of specimens in the first 24 hours is mandated. This becomes difficult at times with the 6-inch molds during large placements and high volume of cylinders requiring curing in bulky containers that are difficult to move around site. With the 4-inch molds medium to large coolers could be used, allowing for more efficient curing and mobility.
- Less chance of damage to test specimens in transit, the smaller specimen will allow for more effective means of protecting specimens during transport to laboratory.
- Smaller specimens will reduce the risk of injury (fingers and hand / back) to technicians in field and lab. A typical 6-inch concrete cylinder can weigh in excess of 28-lbs while 4-inch specimens weight around 8-lbs. Injuries related to repetitive handling of the heavier, awkward and wet (due to curing) 6-inch cylinders occur regularly. The use of smaller cylinders minimizes these injuries and reduces the potential for damage to test specimens.
- Better curing and ease of handling will enhance the testing process resulting in improved consistency of test results

The smaller molds are now the standard used for acceptance on all Virginia DOT projects and for quality control in other segments of the concrete industry (pre-cast and ready mixed concrete producers).

Designation: C 31/C 31M – 06

Standard Practice for Making and Curing Concrete Test Specimens in the Field[1]

This standard is issued under the fixed designation C 31/C 31M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This practice covers procedures for making and curing cylinder and beam specimens from representative samples of fresh concrete for a construction project.

1.2 The concrete used to make the molded specimens shall be sampled after all on-site adjustments have been made to the mixture proportions, including the addition of mix water and admixtures. This practice is not satisfactory for making specimens from concrete not having measurable slump or requiring other sizes or shapes of specimens.

1.3 The values stated in either inch-pound units or SI units shall be regarded separately as standard. The SI units are shown in brackets. The values stated may not be exact equivalents; therefore each system must be used independently of the other. Combining values from the two units may result in nonconformance.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* (**Warning**—Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to exposed skin and tissue upon prolonged exposure.[2])

1.5 The text of this standard references notes which provide explanatory material. These notes shall not be considered as requirements of the standard.

2. Referenced Documents

2.1 *ASTM Standards:* [3]

C 125 Terminology Relating to Concrete and Concrete Aggregates

C 138/C 138M Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete

C 143/C 143M Test Method for Slump of Hydraulic-Cement Concrete

C 172 Practice for Sampling Freshly Mixed Concrete

C 173/C 173M Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

C 231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

C 330 Specification for Lightweight Aggregates for Structural Concrete

C 403/C 403M Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

C 470/C 470M Specification for Molds for Forming Concrete Test Cylinders Vertically

C 511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes

C 617 Practice for Capping Cylindrical Concrete Specimens

C 1064/C 1064M Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

2.2 *American Concrete Institute Publication:*[4]

CP-1 Concrete Field Testing Technician, Grade I

309R Guide for Consolidation of Concrete

3. Terminology

3.1 For definitions of terms used in this practice, refer to Terminology C 125.

4. Significance and Use

4.1 This practice provides standardized requirements for making, curing, protecting, and transporting concrete test specimens under field conditions.

4.2 If the specimens are made and standard cured, as stipulated herein, the resulting strength test data when the specimens are tested are able to be used for the following purposes:

4.2.1 Acceptance testing for specified strength,

[1] This practice is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.61 on Testing for Strength.

Current edition approved Aug. 1, 2006. Published August 2006. Originally approved in 1920. Last previous edition approved in 2003 as C 31/C 31M-03a.

[2] See Section on Safety Precautions, Manual of Aggregate and Concrete Testing, *Annual Book of ASTM Standards*, Vol. 04.02.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[4] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.aci-int.org.

***A Summary of Changes section appears at the end of this standard.**

4.2.2 Checking adequacy of mixture proportions for strength, and

4.2.3 Quality control.

4.3 If the specimens are made and field cured, as stipulated herein, the resulting strength test data when the specimens are tested are able to be used for the following purposes:

4.3.1 Determination of whether a structure is capable of being put in service,

4.3.2 Comparison with test results of standard cured specimens or with test results from various in-place test methods,

4.3.3 Adequacy of curing and protection of concrete in the structure, or

4.3.4 Form or shoring removal time requirements.

5. Apparatus

5.1 *Molds, General*— Molds for specimens or fastenings thereto in contact with the concrete shall be made of steel, cast iron, or other nonabsorbent material, nonreactive with concrete containing portland or other hydraulic cements. Molds shall hold their dimensions and shape under all conditions of use. Molds shall be watertight during use as judged by their ability to hold water poured into them. Provisions for tests of water leakage are given in the Test Methods for Elongation, Absorption, and Water Leakage section of Specification C 470/C 470M. A suitable sealant, such as heavy grease, modeling clay, or microcrystalline wax shall be used where necessary to prevent leakage through the joints. Positive means shall be provided to hold base plates firmly to the molds. Reusable molds shall be lightly coated with mineral oil or a suitable nonreactive form release material before use.

5.2 *Cylinder Molds*— Molds for casting concrete test specimens shall conform to the requirements of Specification C 470/C 470M.

5.3 *Beam Molds*—Beam molds shall be of the shape and dimensions required to produce the specimens stipulated in 6.2. The inside surfaces of the molds shall be smooth. The sides, bottom, and ends shall be at right angles to each other and shall be straight and true and free of warpage. Maximum variation from the nominal cross section shall not exceed ⅛ in. [3 mm] for molds with depth or breadth of 6 in. [150 mm] or more. Molds shall produce specimens at least as long but not more than 1/16 in. [2 mm] shorter than the required length in 6.2.

5.4 *Tamping Rod*— A round, straight steel rod with the dimensions conforming to those in Table 1, having the tamping end or both ends rounded to a hemispherical tip of the same diameter as the rod.

5.5 *Vibrators*—Internal vibrators shall be used. The vibrator frequency shall be at least 7000 vibrations per minute [150 Hz] while the vibrator is operating in the concrete. The diameter of a round vibrator shall be no more than one-fourth the diameter of the cylinder mold or one-fourth the width of the beam mold. Other shaped vibrators shall have a perimeter equivalent to the circumference of an appropriate round vibrator. The combined length of the vibrator shaft and vibrating element shall exceed the depth of the section being vibrated by at least 3 in. [75 mm]. The vibrator frequency shall be checked periodically.

TABLE 1 Tamping Rod Requirements

Diameter of Cylinder or Width of Beam in. [mm]	Rod Dimensions[A]	
	Diameter in. [mm]	Length of Rod in. [mm]
<6 [150]	3/8 [10]	12 [300]
6 [150]	5/8 [16]	20 [500]
9 [225]	5/8 [16]	26 [650]

[A] Rod tolerances length ±4 in. [100 mm] and diameter ±1/16 in. [2 mm].

NOTE 1—For information on size and frequency of various vibrators and a method to periodically check vibrator frequency see ACI 309R.

5.6 *Mallet*—A mallet with a rubber or rawhide head weighing 1.25 ± 0.50 lb [0.6 ± 0.2 kg] shall be used.

5.7 *Small Tools*— Shovels, hand-held floats, scoops, and a vibrating-reed tachometer shall be provided.

5.8 *Slump Apparatus*— The apparatus for measurement of slump shall conform to the requirements of Test Method C 143/C 143M.

5.9 *Sampling Receptacle*—The receptacle shall be a suitable heavy gage metal pan, wheelbarrow, or flat, clean nonabsorbent board of sufficient capacity to allow easy remixing of the entire sample with a shovel or trowel.

5.10 *Air Content Apparatus*—The apparatus for measuring air content shall conform to the requirements of Test Methods C 173/C 173M or C 231.

5.11 *Temperature Measuring Devices*—The temperature measuring devices shall conform to the applicable requirements of Test Method C 1064/C 1064M.

6. Testing Requirements

6.1 *Cylindrical Specimens*—Compressive or splitting tensile strength specimens shall be cylinders cast and allowed to set in an upright position. The length shall be twice the diameter. The cylinder diameter shall be at least 3 times the nominal maximum size of the coarse aggregate. When the nominal maximum size of the coarse aggregate exceeds 2 in. [50 mm], the concrete sample shall be treated by wet sieving through a 2-in. [50-mm] sieve as described in Practice C 172. For acceptance testing for specified compressive strength, cylinders shall be 6 by 12 in. [150 by 300 mm] or 4 × 8 in. [100 × 200 mm] (Note 2).

NOTE 2—When molds in SI units are required and not available, equivalent inch-pound unit size mold should be permitted.

6.2 *Beam Specimens*— Flexural strength specimens shall be beams of concrete cast and hardened in the horizontal position. The length shall be at least 2 in. [50 mm] greater than three times the depth as tested. The ratio of width to depth as molded shall not exceed 1.5. The standard beam shall be 6 by 6 in. [150 by 150 mm] in cross section, and shall be used for concrete with nominal maximum size coarse aggregate up to 2 in. [50 mm]. When the nominal maximum size of the coarse aggregate exceeds 2 in. [50 mm], the smaller cross sectional dimension of the beam shall be at least three times the nominal maximum size of the coarse aggregate. Unless required by project specifications, beams made in the field shall not have a width or depth of less than 6 in. [150 mm].

6.3 *Field Technicians*—The field technicians making and curing specimens for acceptance testing shall be certified ACI Field Testing Technicians, Grade I or equivalent. Equivalent personnel certification programs shall include both written and performance examinations, as outlined in ACI CP-1.

7. Sampling Concrete

7.1 The samples used to fabricate test specimens under this standard shall be obtained in accordance with Practice C 172 unless an alternative procedure has been approved.

7.2 Record the identification of the sample with respect to the location of the concrete represented and the time of casting.

8. Slump, Air Content, and Temperature

8.1 *Slump*—Measure and record the slump of each batch of concrete from which specimens are made immediately after remixing in the receptacle, as required in Test Method C 143/C 143M.

8.2 *Air Content*— Determine and record the air content in accordance with either Test Method C 173/C 173M or Test Method C 231. The concrete used in performing the air content test shall not be used in fabricating test specimens.

8.3 *Temperature*— Determine and record the temperature in accordance with Test Method C 1064/C 1064M.

NOTE 3—Some specifications may require the measurement of the unit weight of concrete. The volume of concrete produced per batch may be desired on some projects. Also, additional information on the air content measurements may be desired. Test Method C 138/C 138M is used to measure the unit weight, yield, and gravimetric air content of freshly mixed concrete.

9. Molding Specimens

9.1 *Place of Molding*— Mold specimens promptly on a level, rigid surface, free of vibration and other disturbances, at a place as near as practicable to the location where they are to be stored.

9.2 *Casting Cylinders*—Select the proper tamping rod from 5.4 and Table 1 or the proper vibrator from 5.5. Determine the method of consolidation from Table 2, unless another method is specified. If the method of consolidation is rodding, determine molding requirements from Table 3. If the method of consolidation is vibration, determine molding requirements from Table 4. Select a small tool of a size and shape large enough so each amount of concrete obtained from the sampling receptacle will be representative and small enough so concrete is not lost when being placed in the mold. While placing the concrete in the mold, move the small tool around the perimeter of the mold opening to ensure an even distribution of the concrete and minimize segregation. Each layer of concrete shall be consolidated as required. In placing the final layer, add an amount of concrete that will fill the mold after consolidation.

9.3 *Casting Beams*— Select the proper tamping rod from 5.4 and Table 1 or proper vibrator from 5.5. Determine the method of consolidation from Table 2, unless another method is specified. If the method of consolidation is rodding, determine the molding requirements from Table 3. If the method of consolidation is vibration, determine the molding requirements from Table 4. Determine the number of roddings per layer, one for each 2 in.^{2} [14 cm^2] of the top surface area of the beam. Select a small tool, of the size and shape large enough so each amount of concrete obtained from the sampling receptacle is representative and small enough so concrete is not lost when placed in the mold. Each layer shall be consolidated as required. In placing the final layer, add an amount of concrete that will fill the mold after consolidation. Place the concrete so that it is uniformly distributed within each layer with a minimum of segregation.

TABLE 2 Method of Consolidation Requirements

Slump in. (mm)	Method of Consolidation
≥ 1 [25]	rodding or vibration
< 1 [25]	vibration

TABLE 3 Molding Requirements by Rodding

Specimen Type and Size	Number of Layers of Approximately Equal Depth	Number of Roddings per Layer
Cylinders:		
Diameter, in. [mm]		
4 [100]	2	25
6 [150]	3	25
9 [225]	4	50
Beams:		
Width, in. [mm]		
6 [150] to 8 [200]	2	see 9.3
>8 [200]	3 or more equal depths, each not to exceed 6 in. [150 mm].	see 9.3

TABLE 4 Molding Requirements by Vibration

Specimen Type and Size	Number of Layers	Number of Vibrator Insertions per Layer	Approximate Depth of Layer, in. [mm]
Cylinders:			
Diameter, in. [mm]			
4 [100]	2	1	one-half depth of specimen
6 [150]	2	2	one-half depth of specimen
9 [225]	2	4	one-half depth of specimen
Beams:			
Width, in. [mm]			
6 [150] to 8 [200]	1	see 9.4.2	depth of specimen
over 8 [200]	2 or more	see 9.4.2	8 [200] as near as practicable

9.4 *Consolidation*— The methods of consolidation for this practice are rodding or internal vibration.

9.4.1 *Rodding*—Place the concrete in the mold, in the required number of layers of approximately equal volume. Rod each layer with the rounded end of the rod using the required number of roddings. Rod the bottom layer throughout its depth. Distribute the roddings uniformly over the cross section of the mold. For each upper layer, allow the rod to penetrate through the layer being rodded and into the layer below approximately 1 in. [25 mm]. After each layer is rodded, tap the outsides of the mold lightly 10 to 15 times with the mallet, to close any holes left by rodding and to release any large air bubbles that may have been trapped. Use an open hand to tap light-gage single-use cylinder molds which are susceptible to damage if tapped with a mallet. After tapping, spade each layer of the concrete along the sides and ends of beam molds with a trowel or other suitable tool. Underfilled molds shall be adjusted with representative concrete during consolidation of the top layer. Overfilled molds shall have excess concrete removed.

9.4.2 *Vibration*—Maintain a uniform duration of vibration for the particular kind of concrete, vibrator, and specimen mold involved. The duration of vibration required will depend upon the workability of the concrete and the effectiveness of the vibrator. Usually sufficient vibration has been applied as soon as the surface of the concrete has become relatively smooth and large air bubbles cease to break through the top surface. Continue vibration only long enough to achieve proper consolidation of the concrete (see Note 4). Fill the molds and vibrate in the required number of approximately equal layers. Place all the concrete for each layer in the mold before starting vibration of that layer. In compacting the specimen, insert the vibrator slowly and do not allow it to rest on the bottom or sides of the mold. Slowly withdraw the vibrator so that no large air pockets are left in the specimen. When placing the final layer, avoid overfilling by more than ¼ in. [6 mm].

NOTE 4—Generally, no more than 5 s of vibration should be required for each insertion to adequately consolidate concrete with a slump greater than 3 in. [75 mm]. Longer times may be required for lower slump concrete, but the vibration time should rarely have to exceed 10 s per insertion.

9.4.2.1 *Cylinders*—The number of insertions of the vibrator per layer is given in Table 4. When more than one insertion per layer is required distribute the insertion uniformly within each layer. Allow the vibrator to penetrate through the layer being vibrated, and into the layer below, approximately 1 in. [25 mm]. After each layer is vibrated, tap the outsides of the mold at least 10 times with the mallet, to close holes that remain and to release entrapped air voids. Use an open hand to tap cardboard and single-use metal molds that are susceptible to damage if tapped with a mallet.

9.4.2.2 *Beams*—Insert the vibrator at intervals not exceeding 6 in. [150 mm] along the center line of the long dimension of the specimen. For specimens wider than 6 in., use alternating insertions along two lines. Allow the shaft of the vibrator to penetrate into the bottom layer approximately 1 in. (25 mm). After each layer is vibrated, tap the outsides of the mold sharply at least 10 times with the mallet to close holes left by vibrating and to release entrapped air voids.

9.5 *Finishing*—After consolidation, strike off excess concrete from the surface and float or trowel as required. Perform all finishing with the minimum manipulation necessary to produce a flat even surface that is level with the rim or edge of the mold and that has no depressions or projections larger than ⅛ in. [3.3 mm].

9.5.1 *Cylinders*—After consolidation, finish the top surfaces by striking them off with the tamping rod where the consistency of the concrete permits or with a wood float or trowel. If desired, cap the top surface of freshly made cylinders with a thin layer of stiff portland cement paste which is permitted to harden and cure with the specimen. See section on Capping Materials of Practice C 617.

9.5.2 *Beams*—After consolidation of the concrete, use a hand-held float to strike off the top surface to the required tolerance to produce a flat, even surface.

9.6 *Identification*— Mark the specimens to positively identify them and the concrete they represent. Use a method that will not alter the top surface of the concrete. Do not mark the removable caps. Upon removal of the molds, mark the test specimens to retain their identities.

10. Curing

10.1 *Standard Curing*— Standard curing is the curing method used when the specimens are made and cured for the purposes stated in 4.2.

10.1.1 *Storage*—If specimens cannot be molded at the place where they will receive initial curing, immediately after finishing move the specimens to an initial curing place for storage. The supporting surface on which specimens are stored shall be level to within ¼ in. per ft [20 mm per m]. If cylinders in the single use molds are moved, lift and support the cylinders from the bottom of the molds with a large trowel or similar device. If the top surface is marred during movement to place of initial storage, immediately refinish.

10.1.2 *Initial Curing*— Immediately after molding and finishing, the specimens shall be stored for a period up to 48 h in a temperature range from 60 and 80 °F [16 and 27 °C] and in an environment preventing moisture loss from the specimens. For concrete mixtures with a specified strength of 6000 psi [40 MPa] or greater, the initial curing temperature shall be between 68 and 78 °F [20 and 26 °C]. Various procedures are capable of being used during the initial curing period to maintain the specified moisture and temperature conditions. An appropriate procedure or combination of procedures shall be used (Note 5). Shield all specimens from the direct sunlight and, if used, radiant heating devices. The storage temperature shall be controlled by use of heating and cooling devices, as necessary. Record the temperature using a maximum-minimum thermometer. If cardboard molds are used, protect the outside surface of the molds from contact with wet burlap or other sources of water.

NOTE 5—A satisfactory moisture environment can be created during the initial curing of the specimens by one or more of the following procedures: (1) immediately immerse molded specimens with plastic lids in water saturated with calcium hydroxide, (2) store in properly constructed wooden boxes or structures, (3) place in damp sand pits, (4) cover with removable plastic lids, (5) place inside plastic bags, or (6) cover with plastic sheets or nonabsorbent plates if provisions are made to avoid drying and damp burlap is used inside the enclosure, but the burlap is prevented from contacting the concrete surfaces. A satisfactory temperature environment can be controlled during the initial curing of the specimens by one or more of the following procedures: (1) use of ventilation, (2) use of ice, (3) use of thermostatically controlled heating or cooling devices, or (4) use of heating methods such as stoves or light bulbs. Other suitable methods may be used provided the requirements limiting specimen storage temperature and moisture loss are met. For concrete mixtures with a specified strength of 6000 psi [40 MPa] or greater, heat generated during the early ages may raise the temperature above the required storage temperature. Immersion in water saturated with calcium hydroxide may be the easiest method to maintain the required storage temperature. When specimens are to be immersed in water saturated with calcium hydroxide, specimens in cardboard molds or other molds that expand when immersed in water should not be used. Early-age strength test results may be lower when stored at 60 °F [16 °C] and higher when stored at 80 °F [27 °C]. On the other hand, at later ages, test results may be lower for higher initial storage temperatures.

10.1.3 *Final Curing:*

10.1.3.1 *Cylinders*—Upon completion of initial curing and within 30 min after removing the molds, cure specimens with

free water maintained on their surfaces at all times at a temperature of 73 ± 3 °F [23 ± 2 °C] using water storage tanks or moist rooms complying with the requirements of Specification C 511, except when capping with sulfur mortar capping compound and immediately prior to testing. When capping with sulfur mortar capping compound, the ends of the cylinder shall be dry enough to preclude the formation of steam or foam pockets under or in cap larger than ¼ in. [6 mm] as described in Practice C 617. For a period not to exceed 3 h immediately prior to test, standard curing temperature is not required provided free moisture is maintained on the cylinders and ambient temperature is between 68 and 86 °F [20 and 30 °C].

10.1.3.2 *Beams*—Beams are to be cured the same as cylinders (see 10.1.3.1) except that they shall be stored in water saturated with calcium hydroxide at 73 ± 3 °F [23 ± 2 °C] at least 20 h prior to testing. Drying of the surfaces of the beam shall be prevented between removal from water storage and completion of testing.

NOTE 6—Relatively small amounts of surface drying of flexural specimens can induce tensile stresses in the extreme fibers that will markedly reduce the indicated flexural strength.

10.2 *Field Curing*— Field curing is the curing method used for the specimens made and cured as stated in 4.3.

10.2.1 *Cylinders*—Store cylinders in or on the structure as near to the point of deposit of the concrete represented as possible. Protect all surfaces of the cylinders from the elements in as near as possible the same way as the formed work. Provide the cylinders with the same temperature and moisture environment as the structural work. Test the specimens in the moisture condition resulting from the specified curing treatment. To meet these conditions, specimens made for the purpose of determining when a structure is capable of being put in service shall be removed from the molds at the time of removal of form work.

10.2.2 *Beams*—As nearly as practicable, cure beams in the same manner as the concrete in the structure. At the end of 48 ± 4 h after molding, take the molded specimens to the storage location and remove from the molds. Store specimens representing pavements of slabs on grade by placing them on the ground as molded, with their top surfaces up. Bank the sides and ends of the specimens with earth or sand that shall be kept damp, leaving the top surfaces exposed to the specified curing treatment. Store specimens representing structure concrete as near the point in the structure they represent as possible, and afford them the same temperature protection and moisture environment as the structure. At the end of the curing period leave the specimens in place exposed to the weather in the same manner as the structure. Remove all beam specimens from field storage and store in water saturated with calcium hydroxide at 73 ± 3 °F [23 ± 2 °C] for 24 ± 4 h immediately before time of testing to ensure uniform moisture condition from specimen to specimen. Observe the precautions given in 10.1.3.2 to guard against drying between time of removal from curing to testing.

10.3 *Structural Lightweight Concrete Curing*—Cure structural lightweight concrete cylinders in accordance with Specification C 330.

11. Transportation of Specimens to Laboratory

11.1 Prior to transporting, cure and protect specimens as required in Section 10. Specimens shall not be transported until at least 8 h after final set. (See Note 7). During transporting, protect the specimens with suitable cushioning material to prevent damage from jarring. During cold weather, protect the specimens from freezing with suitable insulation material. Prevent moisture loss during transportation by wrapping the specimens in plastic, wet burlap, by surrounding them with wet sand, or tight fitting plastic caps on plastic molds. Transportation time shall not exceed 4 h.

NOTE 7—Setting time may be measured by Test Method C 403/C 403M.

12. Report

12.1 Report the following information to the laboratory that will test the specimens:

12.1.1 Identification number,

12.1.2 Location of concrete represented by the samples,

12.1.3 Date, time and name of individual molding specimens,

12.1.4 Slump, air content, and concrete temperature, test results and results of any other tests on the fresh concrete and any deviations from referenced standard test methods, and

12.1.5 Curing method. For standard curing method, report the initial curing method with maximum and minimum temperatures and final curing method. For field curing method, report the location where stored, manner of protection from the elements, temperature and moisture environment, and time of removal from molds.

13. Keywords

13.1 beams; casting samples; concrete; curing; cylinders; testing

SUMMARY OF CHANGES

Committee C09 has identified the location of selected changes to this practice since the last issue, C 31/C 31M – 03a, that may impact the use of this practice. (Approved August 1, 2006)

(*1*) Revised 1.4.

(*2*) Revised 6.1.

Acceptance Testing Using 4 x 8 in. Cylinders

A step toward a precision statement within ASTM C 39

BY RACHEL J. DETWILER, TERRY E. SWOR, AND WENDY THOMAS

In many locations within the U.S., 6 x 12 in. (150 x 300 mm) cylinders are the standard specimens for acceptance testing of concrete compressive strength. Although the current version of ASTM C 31[1] allows the use of 4 x 8 in. (100 x 200 mm) cylinders "when specified," ASTM C 39[2] lacks a precision statement for between-laboratory tests of 4 x 8 in. cylinders cast and cured under field conditions. Because this implies a status short of parity with 6 x 12 in. cylinders, however, many engineers are reluctant to specify the use of 4 x 8 in. specimens (see sidebar on "Surveying the Field").

Clearly, when compared with 6 x 12 in. specimens, 4 x 8 in. specimens:

- Are easier to store and protect on construction sites and could therefore facilitate the use of on-site curing baths;
- Are easier to handle and could therefore increase quality by improving safety (see sidebar on "How Safety Can Result in Better Quality");
- Require less material for molds, capping compound, and for the cylinders themselves and could therefore provide significantly lower material costs;
- Require less storage space and could therefore reduce demand for curing rooms during peak construction seasons; and
- Have less than half the cross-sectional area and could therefore allow more existing testing machines to be used for testing high-strength concretes.

Because these are strong advantages, we believe that an additional precision statement in ASTM C 39, providing verification of the acceptability of 4 x 8 in. cylinders, is warranted.

SURVEYING THE FIELD

To obtain opinions regarding 4 x 8 in. and 6 x 12 in. cylinders for acceptance testing of concrete, American Engineering Testing, Inc., conducted an online survey of readers of its newsletter, *The American Edge*.[a,b] The respondents had diverse backgrounds—characterizing their functions in the construction industry as:

Contractor	4%
Structural Engineer	2%
Construction Manager	2%
Civil Engineer	34%
Materials Supplier	4%
Technician	46%
Architect	6%
Government Employee	2%

Of the total, 38% indicated that they were involved in the process of writing project specifications. Within the group comprising contractors, construction managers, material suppliers, architects, and structural engineers (those normally not directly involved in day-to-day cylinder testing), 10% were opposed to the use of 4 x 8 in. cylinders, citing the lack of an outright qualification of 4 x 8 in. cylinders within ASTM C 31.

References

a. Wirth, D., "Concrete Test Specimens, Does Cylinder Size Matter?" *The American Edge*, American Engineering Testing, Inc., V. 7, No. 4, Winter 2002/2003, p. 4.

b. Wirth, D., "Survey Sez ...Smaller Cylinder Mold Favored for Concrete Test Specimens," *The American Edge*, American Engineering Testing, Inc., V. 8, No. 3, Fall 2003, pp. 2-3.

HOW SAFETY CAN RESULT IN BETTER QUALITY

The number one asset of any business today is people. Every employer is looking for means of protecting that asset by reducing injuries that can shorten the careers of valuable contributors. For testing laboratories, there is significant motivation to reduce the potential for back injuries and burns to workers by switching to 4 x 8 in. cylinders for concrete acceptance testing. A 2/3 reduction in the average load a worker is required to lift on a repetitive basis not only expands the pool of eligible workers (for example, to include more women), but also improves the prospects for longevity of service. Selecting the best people from a larger candidate group should result in a more capable work force and better-quality testing.

Safety is also a strong motivator for workers. If workers perceive that their employer cares about their safety and has made the workplace as safe as possible, they'll concentrate more on doing their jobs correctly and accurately.

BUILDING ON PREVIOUS WORK

Gonnerman found that the minimum dimension of the specimen must be at least three times the maximum aggregate size.[3] Although Forstie and Schnormeier found that, for higher strength concrete, 4 x 8 in. cylinders show somewhat higher strengths than 6 x 12 in. cylinders,[4] compressive strength results have generally been shown to be comparable for a range of specimen sizes up to 6 x 12 in.[3-7] In addition, finite element analyses have shown that the stress distributions are essentially the same for 4- and 6-in. (100- and 150-mm) diameter specimens.[7] Relatively few studies, however, have been conducted to verify the precision of measurements made using different specimen sizes.

Day analyzed the relationship among compressive strengths measured on 3-, 4-, and 6-in. (75-, 100-, and 150-mm) diameter cylinders, as well as the precision of these measurements.[8] He found that for the 4- and 6-in. diameter specimens, the coefficients of variation were equivalent for any given strength range. He also found the strength for 4-in. cylinders cast in plastic or steel molds to be about 5% higher than for 6-in. cylinders.

The Washington Area Council of Engineering Laboratories and the DC Ready Mixed Concrete Producers Technical Committee jointly sponsor an annual round robin test program. Lobo reported that in the 2005 study, 58 laboratories participated in a comparison of compressive strengths using 4 x 8 in. and 6 x 12 in. cylinders.[9] The test program was based on ASTM C 802[10] and the results were analyzed according to ASTM C 670.[11] The cylinders were cast and cured for the first 24 hours under laboratory conditions. Personnel from participating laboratories picked up the specimens the next day and tested them at an age of 28 days. The single-operator and multilaboratory coefficients of variation reported are shown in Table 1.

TABLE 1:
COEFFICIENTS OF VARIATION FOR LABORATORY-PREPARED CYLINDERS[9]

	Coefficient of variation			
	6 x 12 in. cylinders		4 x 8 in. cylinders	
Concrete strength	Single-operator	Multi-laboratory	Single-operator	Multi-laboratory
Low	2.2%	4.0%	2.9%	5.5%
Medium	2.7%	5.3%	2.5%	5.4%

TABLE 2:
PROPERTIES OF FRESH CONCRETE

Nominal strength, psi (MPa)	Slump, in. (mm)	Air content, %	Temperature, °F (°C)
3000 (21)	3 (75)	2.3	55 (13)
4000 (28)	2-½ (65)	2.3	67 (19)
5000 (34)	2-¾ (70)	3.5	60 (16)
6000 (41)	3-½ (90)	2.0	68 (20)
8000 (55)	8-¼ (210)	2.6	59 (15)

EXPERIMENTAL PROGRAM

Although previous comparison studies have adequately demonstrated that the strength results obtained with 4 x 8 in. and 6 x 12 in. specimens are comparable, there are no data on which to base a precision statement pertaining to 4 x 8 in. specimens cast and cured under field conditions. Thus, we focused our test program on obtaining the data for the needed precision statement.

Making and distributing the specimens

The test program was based on the requirements of ASTM C 802. A series of five concretes of different specified strengths were cast on a single morning by a team of ACI Certified Concrete Field Testing Technicians. The concrete was supplied by two local ready mixed concrete producers.

The properties of the fresh concrete are shown in Table 2. Because they are proprietary, the concrete mixture proportions are not reported here.

Fig. 1: Water was added to cover cylinders

Fig. 2: Eight cylinders were placed in each cooler for curing overnight. Min/max thermometers recorded water temperature

After the test specimens were cast, they were grouped into sets of eight and placed in coolers for initial curing. Because the specimens generate heat while curing, four additional specimens were cast for each batch of concrete to make equal the number of specimens per cooler. Water was added to the coolers (Fig. 1) to cover the cylinders and mimic best-practice field curing conditions. Min/max thermometers (Fig. 2) were used to verify that the water temperature remained within the range specified in ASTM C 31 for initial curing.

The following day, randomly-assigned cylinders were packed into unmarked coolers for delivery to the testing laboratories. The randomization was performed to ensure that variations in curing temperature would not bias the test results. The delivery routes were established to ensure that all specimens would arrive at the testing laboratories within 4 hours of leaving the laboratory where they were made. To maintain anonymity, the laboratories reported their test results directly to the statistician.

Testing

Twenty laboratories, listed in Table 3, participated in the test program. After the test specimens were delivered, they were unpacked from the coolers, demolded, and placed in a curing facility (either a moist room or a curing trough) until they reached an age of 28 days. Laboratories were permitted to use either capping compound or neoprene caps of the appropriate strength to prepare the specimens for testing.

RESULTS AND DISCUSSION

Two laboratories encountered problems that precluded the use of their data in the analysis. In one case, the specimen labels were lost during shipping; in another case, a testing machine malfunctioned. The remaining 18 laboratories provided acceptable data for all strength levels.

TABLE 3:
PARTICIPATING LABORATORIES

Laboratory name, location
Aggregate Industries, Minneapolis, MN
American Engineering and Testing, St. Paul, MN
American Engineering and Testing, Duluth, MN
American Engineering and Testing, Mankato, MN
American Engineering and Testing, Rochester, MN
Braun Intertec Corp., Bloomington, MN
Braun Intertec Corp., La Crosse, WI
Braun Intertec Corp., Rochester, MN
Braun Intertec Corp., St. Cloud, MN
Braun Intertec Corp., St. Paul, MN
Cemstone, Mendota Heights, MN
Construction Engineering Laboratory, New Hope, MN
McGhie & Betts, Northfield, MN
Minnesota Department of Transportation, Mankato, MN
Minnesota Department of Transportation, Maplewood, MN
Minnesota Department of Transportation, Rochester, MN
Minnesota Department of Transportation, St. Cloud, MN
Minnesota State University, Mankato, MN
Northern Technologies, Ramsey, MN
Twin City Testing, St. Paul, MN

The test results are shown in Table 4. As required by ASTM C 802, the values are reported to more significant digits than for typical tests. The individual results are

TABLE 4:
28-DAY COMPRESSIVE STRENGTHS OF 4 X 8 IN. (100 X 200 MM) CONCRETE CYLINDERS, PSI (1 PSI = 0.0069 MPA)

Laboratory	Replicate	Nominal strength				
		3000 psi	4000 psi	5000 psi	6000 psi	8000 psi
1	A	5552	7226	7588	7083	10,456
	B	5556	7088	8014	7791	10,368
	C	5535	6963	7305	7256	10,235
2	A	5056	6762	7520	7622	10,137
	B	5191	6937	7399	7561	10,361
	C	5148	6827	7106	7517	10,255
4	A	5532	7350	7954	7484	10,302
	B	5531	7617	7115	8072	10,290
	C	5515	7290	7484	7778	10,260
5	A	5730	7321	7640	7560	11,459
	B	5292	6963	7998	8515	10,584
	C	5093	7083	7799	8276	10,982
6	A	5809	7481	7799	7640	10,783
	B	5770	7759	7719	7918	10,783
	C	5889	7520	7560	8157	10,345
7	A	5499	7224	7379	7462	9717
	B	5622	6802	7376	7484	10,235
	C	5581	7508	7532	7767	10,084
8	A	5583	7219	7675	7541	10,254
	B	5535	7429	7893	7925	10,664
	C	5661	7204	7652	7718	10,349
9	A	5359	7079	7150	7589	9621
	B	5507	7102	7540	7683	9362
	C	5390	6838	7354	7404	9416
10	A	5380	6676	7615	7737	9958
	B	5126	6857	7282	7562	10,035
	C	5380	7322	7707	7791	9857
12	A	5601	7049	7640	7837	10,043
	B	5493	6724	7033	7177	9957
	C	5628	6782	7065	7170	9717
13	A	5674	6782	7436	7162	9593
	B	5583	7303	7387	6819	9412
	C	5614	6806	7175	7079	9756
14	A	6072	7218	7759	6661	9327
	B	5602	7520	7345	7393	10,123
	C	5634	7250	7751	7106	9080

consistently well above the specified strengths—a reflection of the common practice among local ready mixed concrete companies to withhold some of the mixing water. The mean strengths for the mixtures with 4000-, 5000- and 6000-psi (28-, 34-, and 41-MPa) nominal strengths were within a range of about 7000 to 8000 psi (48 to 55 MPa). However, although there was not a significant difference between the mean strength results for the 5000 and 6000 psi (34 and 41 MPa) strength groups, there was a significant difference between the mean strengths for the 4000 and 5000 psi (28 and 34 MPa) groups.

Single-operator variance

In accordance with the procedures specified in ASTM C 802, the mean strengths $\bar{x}_i$ and single-operator variances s_i^2 were calculated for each laboratory and nominal concrete strength (Table 5). In Fig. 3, single-operator variance is graphed for three of the nominal concrete strengths. The red line on each graph is the mean variance, and the blue line is the calculated 5% upper bound. The ratio of the highest individual variance to the sum of the variances was also calculated and compared to the upper 5% level for this ratio. In the 3000 psi (21 MPa) class, the variance for Laboratory 5 was identified as being slightly out of range (a ratio of 0.3193 compared to an upper 5% level value of 0.2961). Also, in the 8000 psi (55 MPa) class, the variance for Laboratory 14 was identified as being slightly out of range (a ratio of 0.2996 compared to an upper 5% level value of 0.2961). As this is a measure of laboratory consistency, the variances of Laboratories 5 and 14 were examined in the other strength classes. All other variances for these two laboratories were within range, and many were very close to the group averages. Therefore, the results from Laboratories 5 and 14 were retained.

TABLE 4: (CONT.)

15	A	5257	6984	6939	7831	10,086
	B	5434	6769	6892	7596	9651
	C	5198	6901	7234	7702	9575
16	A	5190	7236	7698	8324	11,687
	B	5492	7462	8170	9022	11,586
	C	5647	7410	8159	8605	11,719
17	A	5210	6997	7365	7799	10,175
	B	5358	7002	7163	7849	9755
	C	5074	6920	7176	7955	9750
18	A	5729	7652	7430	7430	10,594
	B	5725	7488	7792	7978	10,676
	C	5739	7044	7932	7828	10,637
19	A	5517	6966	6974	7239	9869
	B	5446	6894	7241	7620	10,112
	C	5479	7281	7219	7442	9964
20	A	5475	7656	7815	7823	9812
	B	5411	6900	7783	7823	10,274
	C	5236	7162	7377	7839	10,035

TABLE 5:
AVERAGE $\bar{X}_i$ AND SINGLE-OPERATOR VARIANCE S_i^2 VALUES (1 PSI = 0.0069 MPA)

	3000 psi nominal strength		4000 psi nominal strength		5000 psi nominal strength		6000 psi nominal strength		8000 psi nominal strength	
Laboratory	$\bar{X}_i$, psi	s_i^2, psi^2	$\bar{X}_i$, psi	s_i^2, psi^2	$\bar{X}_i$, psi	s_i^2, psi^2	$\bar{X}_i$, psi	s_i^2, psi^2	$\bar{X}_i$, psi	s_i^2, psi^2
1	5548	132	7092	17,255	7635	127,381	7377	136,052	10,353	12,401
2	5132	4778	6842	7828	7342	45,461	7567	2784	10,251	12,601
4	5526	94	7419	30,442	7518	176,722	7778	86,230	10,284	459
5	5372	10,6077	7122	33,248	7812	32,192	8117	246,985	11,009	192,099
6	5823	3694	7587	22,693	7693	14,777	7905	67,024	10,637	63,857
7	5567	3941	7178	125,881	7429	7947	7571	28,867	10,012	70,974
8	5593	4021	7284	15,796	7740	17,633	7728	36,859	10,422	46,233
9	5419	6093	7007	21,413	7348	38,039	7558	20,081	9466	18,731
10	5295	21,549	6952	111,154	7535	49,823	7697	14,244	9950	7992
12	5574	5125	6852	30,033	7246	116,476	7395	146,841	9906	28,600
13	5624	2134	6963	86,608	7333	19,273	7020	31,988	9587	29,707
14	5770	68,839	7329	27,612	7618	56,004	7053	136,116	9510	296,825
15	5296	15,028	6885	11,745	7021	34,411	7710	13,919	9771	76,037
16	5443	53,951	7369	13,989	8009	72,521	8650	123,315	11,664	4815
17	5214	20,190	6973	2098	7235	12,815	7868	6341	9893	59,527
18	5731	48	7395	99,157	7718	67,205	7746	80,079	10,635	1681
19	5481	1284	7047	42,273	7144	22,012	7433	36,377	9982	14,965
20	5374	15,284	7239	147,325	7658	59,551	7828	84	10,040	53,281

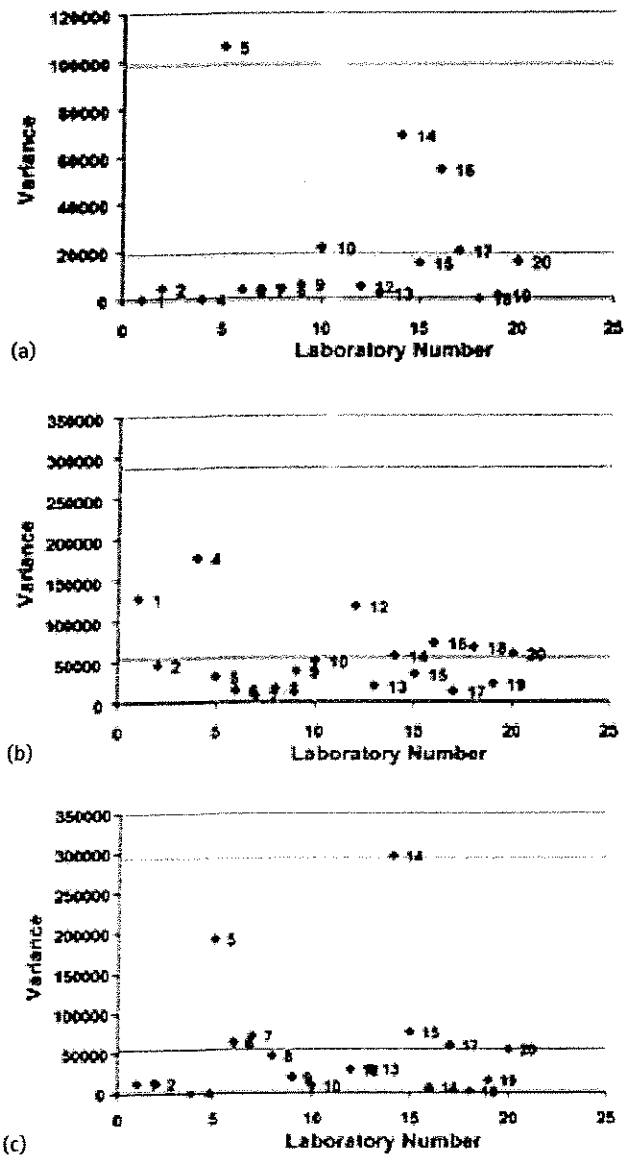

Fig. 3: Single-operator variance versus laboratory for nominal strength classes of: (a) 3000 psi; (b) 5000 psi; and (c) 8000 psi

Multilaboratory variance

Multilaboratory variance was checked by plotting the average strength by laboratory to identify differences in the pattern of change in the results (Fig. 4). All labs showed very similar patterns, indicating minimal interaction between the laboratories and the materials. The plot of mean material strength by lab (Fig. 5) provides a similar check from the perspective of the individual lab, showing any lab that may have means consistently higher or

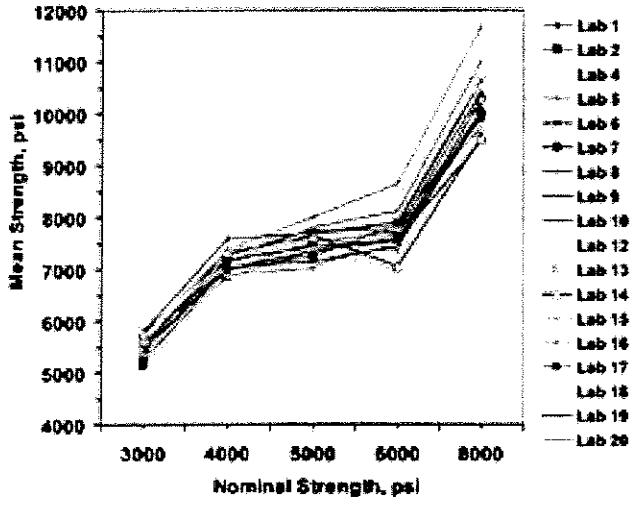

Fig. 4: Mean material strength versus nominal strength for each laboratory (1 psi = 0.0069 MPa)

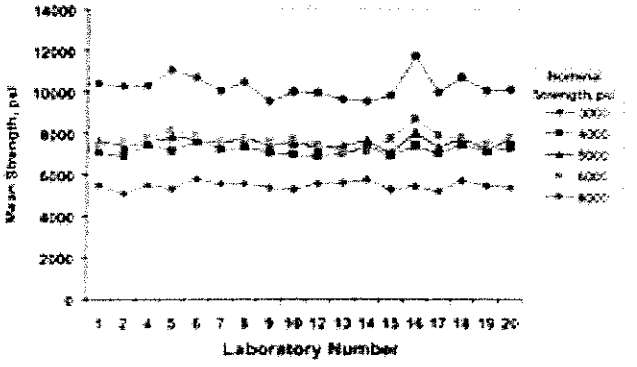

Fig. 5: Mean material strength versus laboratory number (1 psi = 0.0069 MPa)

lower than the others for more than one nominal strength. Multilaboratory variance was also analyzed according to ASTM C 802. The results are summarized in Table 6.

Comparisons with previous analyses

From ASTM C 39, the single-operator coefficient of variation for 6 x 12 in. cylinders cast and cured under standard field conditions is 2.87%. For our study, the single-operator coefficient of variation for 4 x 8 in. cylinders ranged from 2.32 to 3.39%—comparable to the results for the 6 x 12 in. specimens. Further, the single-operator and multilaboratory coefficients of variation obtained in our study compare favorably with those reported by Lobo[9] for both 4 x 8 in. and 6 x 12 in. cylinders (see Table 1) cast and cured under laboratory conditions.

Comparison of results as a function of cap type

Of the 18 laboratories included in the analyses, three used sulfur caps for all cylinders, two laboratories used sulfur caps for 6000 and 8000 psi (41 and 55 MPa) cylinders only, and one used sulfur caps for the 8000 psi (55 MPa) cylinders only. An analysis of the variance between neoprene and sulfur caps within each strength group shows an inconsistent pattern. While the 5000 and 8000 psi (34 and 55 MPa) nominal strength groups showed significantly lower strengths using sulfur caps at a 0.01 level of significance, the 6000 psi (41 MPa) group did not show a significant difference in mean strengths—even at a more generous 0.05 level of significance. For the 5000 psi (34 MPa) strength group, multilaboratory variance was apparently not affected by cap type. For the 8000 psi (55 MPa) strength group, however, cap type was a contributing factor to the multilaboratory variance and resulted in coefficients of variation of 5.74% combined, 4.26% for neoprene caps only, and 2.60% for sulfur caps only. Further investigation with a more balanced sample of neoprene and sulfur caps may result in more consistent multilaboratory variance results across all strengths.

TABLE 6:
SUMMARY OF SINGLE-OPERATOR AND MULTILABORATORY RESULTS (1 PSI = 0.0069 MPA)

Nominal concrete strength, psi	Average strength, psi	Standard deviation, psi		Coefficient of variation, %	
		Single-operator	Multi-laboratory	Single-operator	Multi-laboratory
3000	5488	136	219	2.48	3.99
4000	7141	217	282	3.04	3.96
5000	7485	232	320	3.10	4.27
6000	7659	260	428	3.39	5.59
8000	10,114	235	584	2.32	5.78

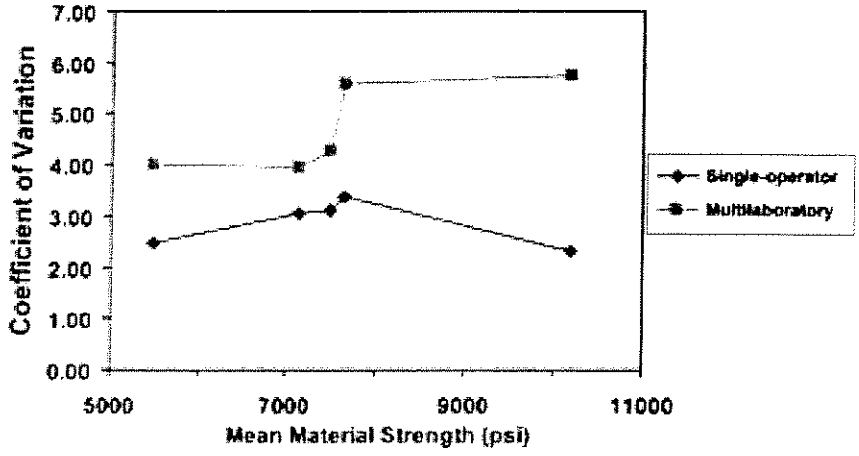

Fig. 6: Single-operator and multilaboratory coefficients of variation versus mean material strength (1 psi = 0.0069 MPa)

General observations

The variability of compressive strength test results for 4 x 8 in. concrete cylinders is roughly comparable to that of 6 x 12 in. concrete cylinders. The coefficients of variation were somewhat higher for tests of concrete mixtures with higher nominal compressive strengths.

The data obtained in this study provide a basis for a precision statement for single-operator and multilaboratory tests of 4 x 8 in. cylinders prepared under standard field conditions. Evaluations of the data further indicated two distinct groups of concrete: those with compressive strengths below 7500 psi (52 MPa) and those with compressive strengths at or above 7500 psi (52 MPa). As shown in Fig. 6, while the single-operator variance was relatively consistent across all strengths, the multilaboratory variance exhibited a significant shift at about 7500 psi (52 MPa). We therefore provide two precision statements for multilaboratory variance.

The insignificant difference between test strengths for the 5000 and 6000 psi (34 and 41 MPa) nominal strength groups and the apparent effect of sulfur caps on multilaboratory variance in the 6000 psi (41 MPa) group (with a coefficient of variation of 5.59%) are significant. The multilaboratory coefficient of variation for the 6000 psi (41 MPa) group was 4.26% for those labs using neoprene caps (the same as the coefficient of variation for all 5000 psi [34 MPa] group tests) and 5.13% for those labs using sulfur caps. Additional testing may therefore be needed to clarify the division point for multiple operator precision statements.

PROPOSED PRECISION STATEMENT

We propose the following precision statement for inclusion in ASTM C 39 for 4 x 8 in. concrete cylinders cast and cured under field conditions:

	Coefficient of variation	Acceptable range of 2 results	Acceptable range of 3 results
Single-operator, field conditions	2.86%	8.09%	9.44%
Multilaboratory, field conditions (combined)	4.71%	13.32%	15.54%
(<7500 psi [<52 MPa])	4.07%	11.52%	13.43%
(≥7500 psi [≥52 MPa])	5.66%	16.03%	18.69%

Acknowledgments

We thank the personnel of the 20 participating laboratories, as well as our concrete suppliers, Aggregate Industries and Cemstone, for their support of this test program. In addition, we gratefully acknowledge the contributions of N. Carino of the National Institute of Standards and Technology, C. Lobo of the National Ready Mixed Concrete Association, and C. Ozyildirim of the Virginia Transportation Research Council in helping us to refine our test plan.

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Received and reviewed under Institute publication policies.

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